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(54) METHOD FOR PREPARING DIAMOND TOOL BIT FROM PURE IRON-BASED MATRIX

(57) The present invention provides use of a pure iron-based matrix for preparing a diamond bit and a method for preparing a diamond bit. The present invention uses the diamond bits prepared from the pure iron-based matrix made of iron powder with an average particle size of 1-25 μm in different scenarios. In the present invention, the iron powder with the average particle size of 1-25 μm is used to shorten a movement distance of iron ions, which greatly enhances activity of the iron powder, is beneficial to improving hardness and strength of the diamond bit, and can increase a holding power and wear resistance to the diamond. In addition, in the present invention, a pressure of hot press sintering of the diamond bit is controlled at 700-860°C, and a temperature of pressureless sintering is controlled at 900-960°C, thereby controlling reaction rate of the iron powder and the diamond, so that the iron powder can form a chemical bond with the diamond, and the diamond is not excessively carbonized to affect the strength of the diamond bit, thereby obtaining the diamond bit with excellent comprehensive performance and low price.

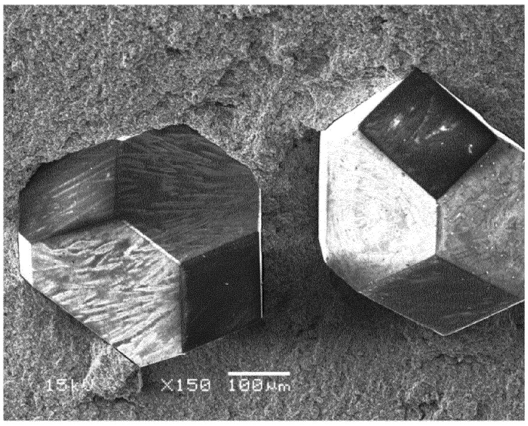

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention pertains to the technical field of diamond, and specifically pertains to use of a pure iron-based matrix for preparing a diamond bit and a method for preparing a diamond bit.

BACKGROUND

[0002] Diamond tools have the characteristics of high sharpness, high hardness and strong wear resistance, and are widely applied to the industries of buildings, automobiles, geology, machinery, electronics, metallurgy and ceramics. A diamond tool is composed of a matrix and a diamond bit, and the matrix mainly plays a supporting role and the diamond bit mainly plays a cutting role. Matrix currently used in the diamond bit on the market can be roughly classified into Co-based matrix, Fe-based matrix, Cu-based matrix and Ni-based matrix according to their main components. The Co-based matrix has excellent red hardness, bezel setting ability and self-sharpening, so the Co-based matrix has the best comprehensive performance. However, Co is a strategically scarce resource, and the use of Co in the diamond bit is greatly limited by high and fluctuating price. In addition, elements such as Co and Ni cause environmental pollution, and the pollutants are also limited from introduction into diamond matrix formulations internationally. Fe and Co belong to the same group elements, which have similar crystal structure and properties, but Fe is much lower in price. Therefore, replacing Co with Fe to reduce costs is always the trend of green development of the diamond bit. According to "Gao Ya. Influence of Ni and Sn on Structure and Properties of Fe-based Diamond Tool Matrix [D]. China Academy of Machinery Science & Technology, 2018", due to low wear resistance of pure iron, inertial thinking of researchers is to add additives to the Fe-based matrix according to existing problems of the Fe-based matrix and different application scenarios of the diamond bit made of the Fe-based matrix. The additives can be alloying elements that react with the Fe-based matrix or some wear-resistant constituents. For example, eutectic elements P, Zn and Sn can increase efficiency of space filling of sintered Fe-based matrix after sintering and improve sintering quality, and for example, strengthening components lanthanum and beryllium can improve the comprehensive properties of the sintered Fe-based matrix, such as hardness, strength and wear resistance. However, this approach increases the performance of the Fe-based matrix at the expense of cost. It would be a qualitative leap for the development of the diamond bit if the best balance of cost and performance could be achieved, but there is currently no report or literature on how to achieve this balance.

SUMMARY

[0003] In order to overcome the problems of the prior art, it is an object of the present invention to provide use of a pure iron-based matrix with good comprehensive properties and low price for preparing a diamond bit.

[0004] In order to achieve the above-mentioned object, the present invention adopts the following technical schemes: Use of a pure iron-based matrix made of iron powder with an average particle size of 1-25 μm for preparing a diamond bit.

[0005] A second object of the present invention is to provide a method for preparing a diamond bit which specifically comprises the following steps:

step S1: mechanically mixing iron powder and diamond and fully mixing to obtain a mixture, where a mass fraction of the iron powder with an average particle size of 1-25 μm is ≥ 40%, and a volume of the diamond is 25-30% of a volume of the iron powder;

Step S2: hot press sintering the mixture obtained in the step S1 for forming and cooling to obtain the diamond bit.

[0006] Preferably, a temperature of the hot-press sintering is 700-860°C, a holding time is 90-120 s, and a pressure of the hot press sintering is 200-400 kgf/cm^2.

[0007] Preferably, in the step S1, the diamond is wetted with a wetting agent and then mechanically mixed with the iron powder, where the wetting agent is a motor oil or paraffin.

[0008] Preferably, in the step S1, a binder with a mass of 1.2-2.2% of a mass of the iron powder is added to be mechanically mixed with the diamond and the iron powder, where the binder is polyethylene glycol or polyvinyl alcohol.

[0009] Accordingly, the present invention also provides a method for preparing a diamond bit which specifically comprises the following steps:

step C1: mechanically mixing iron powder and diamond and fully mixing to obtain a mixture, where a mass fraction of the iron powder with an average particle size of 1-25 μm is ≥ 40%, and a volume of the diamond is 25-30% of a volume of the iron powder;

step C2: preparing the mixture obtained in the step C1 into a body with a density of 3.95-6.29 g/cm^3; and

Step C3: forming the body obtained in the step C2 by pressureless sintering and cooling to obtain the diamond bit.

[0010] Preferably, in the step C3, a temperature of the pressureless sintering is 900-960°C, and a holding time is 30-60 min.

[0011] Preferably, in the step C1, the diamond is wetted with a wetting agent and then mechanically mixed with the iron powder, where the wetting agent is a motor oil or paraffin.

[0012] Preferably, in the step C1, a binder with a mass of 1.2-2.2% of a mass of the iron powder is added to be mechanically mixed with the diamond and the iron powder, where the binder is polyethylene glycol or polyvinyl alcohol.

[0013] Compared with the prior art, the present invention has the following beneficial effects:

(1) The present invention prepares the diamond bit from the pure iron-based matrix made of the iron powder with the average particle size of 1-25 μm. Since the iron powder with the average particle size of 1-25 μm has strong activity and higher mechanical property, movement distance of iron ions can be shortened, which is beneficial to improving hardness and strength of the pure iron-based matrix, and can increase holding power and wear resistance of the pure iron-based matrix to the diamond. The present invention breaks through conventional thinking that some other elements are needed to be added to change the performance of the iron-based matrix in order to improve the performance of the pure iron-based matrix in the prior art, thereby really reducing the preparation cost of the diamond bit and expanding market share of the diamond bit prepared by the present invention.

(2) Since coarse iron powder has a strong affinity for carbon at a high temperature (1000°C), iron in the iron-based matrix forms FeC (cementite) with the diamond during sintering of the diamond bit, but are partially decomposed into carbon in the form of iron and graphite during cooling, thereby graphitizing the diamond surface and reducing the holding power of the pure iron-based matrix to the diamond. However, in the present invention, when the pure iron-based matrix consisting of the iron powder with the average particle size of 1-25 μm is selected to prepare the diamond bit, the temperature of the hot press sintering is controlled at 700-860°C, and the temperature of the pressureless sintering is controlled at 900-960°C, which control a reaction rate of the iron powder and the diamond, and avoid problems that a controllable process range of a preparation process of the diamond bit is narrow, the iron easily erodes the diamond by heat, the holding power is weak, the diamond bit is easily oxidized and fails because a sintering process with high temperature (1000°C) is required to realize the strength and bending resistance of the pure iron-based matrix in the prior art.

(3) Market research conducted by the applicant in the early stage of research and development revealed that the cost of preparing the diamond bit made of the pure iron-based matrix with the average particle size of 1-25 μm is 10-30% of the cost of preparing other diamond bit having the same properties in the market (e.g., the diamond bit made of a Co-based matrix, an Fe-based matrix with other elements, a Cu-based matrix or a Ni-based matrix). The present invention achieves real low-cost manufacture of the diamond bit and breaks through the conventional rule of the industry. In addition, the present invention has ingenious and reasonable design, it seems simple, but it is not easy to think of. Only by in-depth research and combining the characteristics of the iron-based matrix can the best balance between technology and cost be truly realized. The present invention not only breaks through the limitations of the prior art, conforms to the trend of technological development, and achieves innovation, but also promotes the means for preparing the diamond bit to a new height. Accordingly, the present invention represents a significant advance in the art, and has outstanding substantial features and significant progress.

(4) The pure iron-based matrix of the present invention can be prepared into the diamond bits with the best performance and low price in application scenarios by different preparation methods according to the application scenarios of the diamond tools made of the diamond bit, which meets the different demands of the market for the performance of the diamond bits from low to high performance, thereby increasing the market share of the diamond bit prepared by the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is an SEM diagram of diamond in a pure iron-based matrix made of iron powder with an average particle size of 1-3 μm.

DESCRIPTION OF THE EMBODIMENTS

Iron powder:

[0015] Iron powder described in the following examples were sourced from "Ya’an Sagwell Science And Technology Co., Ltd.", and an oxygen content of the iron powder with an average particle size of 1-25 μm in the following examples of the present invention is 2000-7000 PPM. Atomized iron powder and reduced iron powder were sourced from GKN.

Examples:

[0016] The technical schemes of the present invention will be further clearly and completely described with reference to the following examples and comparative examples, where raw materials used in the examples of the present invention, as well as preparation materials, were commercially available.

Example 1

[0017] A method for preparing a diamond bit, comprised the following steps:

Step S1: weighing diamond and iron powder in proportion, then wetting the iron powder with liquid paraffin or a motor oil, and then loading the wetted diamond and the iron powder into a silo, mechanically mixing for 60-90 min, and fully mixing to obtain a mixture, where the iron powder had an average particle size of 1 μm, and a volume of the diamond was 25% of a volume of the iron powder.

Step S2: loading the mixture obtained in the step S1 into a graphite or steel die and performing hot press sintering at 700°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-400 kgf/cm^2.

[0018] And the diamond bit prepared in Example 1 was made into a diamond floor grinding block.

Example 2

[0019] A method for preparing a diamond bit, comprised the following steps:

Step S1: adding iron powder, diamond and a binder into a silo in proportion, mixing by rolling for 30-60 min and sieving to obtain a spherical particle mixture with an average particle size of 60-100 meshes, then loading the spherical particle mixture into a steel die, and cold pressing the mixture into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder had an average particle size of 1 μm, a volume of the diamond was 25% of a volume of the iron powder, the binder was 1.2-2.2% of a mass of the iron powder, and the binder was PEG (polyethylene glycol) or PVA (polyvinyl alcohol).

Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 700°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0020] And the diamond bit prepared in Example 2 was made into a coring thin-wall wet drill bit.

Example 3

[0021] A method for preparing a diamond bit, comprised the following steps:

Step S1: adding iron powder, diamond and a binder into a silo in proportion, mixing by rolling for 30-60 min and sieving to obtain a spherical particle mixture with an average particle size of 60-100 meshes, then loading the spherical particle mixture into a steel die, and cold pressing the mixture into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder had an average particle size of 25 μm, a volume of the diamond was 25% of a volume of the iron powder, the binder was 1.2-2.2% of a mass of the iron powder, and the binder was PEG or PVA.

Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 860°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0022] And the diamond bit prepared in Example 3 was made into a diamond road cutting saw blade.

Example 4

[0023] A method for preparing a diamond bit, comprised the following steps:

Step S1: adding iron powder, diamond and a binder into a silo in proportion, mixing by rolling for 30-60 min and sieving to obtain a spherical particle mixture with an average particle size of 60-100 meshes, then loading the

spherical particle mixture into a steel die, and cold pressing the mixture into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder had an average particle size of 8 μm, a volume of the diamond was 30% of a volume of the iron powder, the binder was 1.2-2.2% of a mass of the iron powder, and the binder was PEG or PVA.
Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 765°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0024] And the diamond bit prepared in Example 4 was made into a diamond ceramic wet grinding wheel.

Example 5

[0025] A method for preparing a diamond bit, comprised the following steps:

Step S1: adding iron powder, diamond and a binder into a silo in proportion, mixing by rolling for 30-60 min and sieving to obtain a spherical particle mixture with an average particle size of 60-100 meshes, then loading the spherical particle mixture into a steel die, and cold pressing the mixture into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder had an average particle size of 1-3 μm, a volume of the diamond was 25% of a volume of the iron powder, the binder was 1.2-2.2% of a mass of the iron powder, and the binder was PEG or PVA.
Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 750°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0026] And the diamond bit prepared in Example 5 was made into a coring thin-wall wet drill bit.

Example 6

[0027] A method for preparing a diamond bit, comprised the following steps:

Step C1: adding iron powder, diamond and a binder into a silo in proportion, mixing by rolling for 30-60 min and sieving to obtain a spherical particle mixture with an average particle size of 60-100 meshes, where the iron powder had an average particle size of 1-3 μm, a volume of the diamond was 30% of a volume of the iron powder, the binder was 1.2-2.2% of a mass of the iron powder, and the binder was PEG or PVA.
Step C2: loading the spherical particle mixture obtained in the step C1 into a steel die, and cold pressing the mixture at a pressure of 0.5-5.5 t/cm^2 into a body with a density of 3.95-6.29 g/cm^3.
Step C3: placing the body obtained in the step C2 into a graphite boat and performing pressureless sintering at 920°C, holding for 30-60 min and cooling after completion of the sintering to obtain the diamond bit.

[0028] And the diamond bit prepared in Example 6 was made into a diamond road cutting saw blade.

Example 7

[0029] A method for preparing a diamond bit, comprised the following steps:

Step S1: ball milling and mixing iron powder and reduced iron powder for 30 min, then loading the iron powder and the reduced iron powder together with diamond into a silo in proportion and mechanically mixing for 60-90 min for thorough mixing to obtain a mixture, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the reduced iron powder with an average particle size of 150 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the reduced iron powder was 50:50, a volume of the diamond was 25% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.
Step S2: loading the mixture obtained in the step S1 into a graphite or steel die and performing hot press sintering at 780°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-400 kgf/cm^2.

[0030] The diamond bit prepared in Example 7 was made into a diamond ceramic grinding block.

Example 8

[0031] A method for preparing a diamond bit, comprised the following steps:

Step S1: ball milling and mixing iron powder and reduced iron powder for 30 min, then loading the iron powder and the reduced iron powder together with diamond into a silo in proportion and mechanically mixing for 60-90 min for thorough mixing to obtain a mixture, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the reduced iron powder with an average particle size of 48 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the reduced iron powder was 70:30, a volume of the diamond was 30% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.
Step S2: loading the mixture obtained in the step S1 into a graphite or steel die and performing hot press sintering at 780°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-400 kgf/cm^2.

[0032] And the diamond bit prepared in Example 8 was made into a diamond floor grinding block.

Example 9

[0033] A method for preparing a diamond bit, comprised the following steps:

Step S1: ball milling and mixing iron powder and reduced iron powder for 30 min, then loading the iron powder and the reduced iron powder together with diamond into a silo in proportion and mechanically mixing for 60-90 min for thorough mixing to obtain a mixture, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the reduced iron powder with an average particle size of 75 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the reduced iron powder was 40:60, a volume of the diamond was 25% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.
Step S2: loading the mixture obtained in the step S1 into a graphite or steel die and performing hot press sintering at 810°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-400 kgf/cm^2.

[0034] And the diamond bit prepared in Example 9 was made into a diamond floor grinding block.

Example 10

[0035] A method for preparing a diamond bit, comprised the following steps:

Step S1: ball milling and mixing iron powder and reduced iron powder for 30 min, then loading the iron powder and the reduced iron powder together with diamond into a silo in proportion and mechanically mixing for 30-60 min for thorough mixing to obtain a mixture, and loading the mixture into a steel die and cold pressure the same into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the reduced iron powder with an average particle size of 40-50 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the reduced iron powder was 50:50, a volume of the diamond was 25% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.
Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 780°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0036] And the diamond bit prepared in Example 10 was made into a coring thin-wall wet drill bit.

Example 11

[0037] A method for preparing a diamond bit, comprised the following steps:

Step C1: ball milling and mixing iron powder and reduced iron powder for 30 min, then loading the iron powder and the reduced iron powder together with diamond into a silo in proportion and mechanically mixing for 30-60 min for thorough mixing to obtain a powder mixture, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the reduced iron powder with an average particle size of 40-50 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the reduced iron powder was 50:50, a volume of the diamond was 30% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.

Step C2: loading the powder mixture obtained in the step C1 into a steel die, and cold pressing the powder mixture at a pressure of 0.5-5.5 t/cm^2 into a body with a density of 70-80%.

Step C3: placing the body obtained in the step C2 into a graphite boat and performing pressureless sintering at 960°C, holding for 30-60 min and cooling after completion of the sintering to obtain the diamond bit.

[0038] The diamond bits prepared in Example 11 were made into a stone saw blade.

Example 12

[0039] A method for preparing a diamond bit, comprised the following steps:

Step S1: ball milling and mixing iron powder and atomized iron powder for 30 min, then loading the iron powder and the atomized iron powder together with diamond into a silo in proportion and mechanically mixing for 30-60 min for thorough mixing to obtain a mixture, and loading the mixture into a steel die and cold pressure the same into a body with a density of 3.95-6.29 g/cm^3 at a pressure of 0.5-5.5 t/cm^2, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the atomized iron powder with an average particle size of 40-50 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the atomized iron powder was 50:50, a volume of the diamond was 30% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.

Step S2: loading the body obtained in the step S1 into a graphite die and performing hot press sintering at 800°C, holding for 90-120 s and cooling after completion of the sintering to obtain the diamond bit, where a pressure of the hot press sintering was 200-300 kgf/cm^2.

[0040] And the diamond bit prepared in Example 12 was made into a coring thin-wall wet drill bit.

Example 13

[0041] A method for preparing a diamond bit, comprised the following steps:

Step C1: ball milling and mixing iron powder and atomized iron powder for 30 min, then loading the iron powder and the atomized iron powder together with diamond into a silo in proportion and mechanically mixing for 30-60 min for thorough mixing to obtain a powder mixture, where the iron powder comprised the iron powder with an average particle size of 1-3 μm and the atomized iron powder with an average particle size of 40-50 μm, a mass ratio of the iron powder with the average particle size of 1-3 μm to the atomized iron powder was 50:50, a volume of the diamond was 30% of a volume of the iron powder, and the diamond was wetted with liquid paraffin or a motor oil before the mechanical mixing.

Step C2: loading the powder mixture obtained in the step C1 into a steel die, and cold pressing the mixture at a pressure of 0.5-5.5 t/cm^2 into a body with a density of 3.95-6.29 g/cm^3.

Step C3: placing the body obtained in the step C2 into a graphite boat and performing pressureless sintering at 900°C, holding for 30-60 min and cooling after completion of the sintering to obtain the diamond bit.

[0042] And the diamond bit prepared in Example 13 was made into a coring thin-wall wet drill bit.

Comparative Example 1

[0043] A diamond bit was prepared according to Example 5 except that the temperature of the hot press sintering was 640°C and the holding time was 80 s.

[0044] And the diamond bit prepared in Comparative Example 1 was made into a coring thin-wall wet drill bit.

Comparative Example 2

[0045] A diamond bit was prepared according to Example 5 except that the temperature of the hot press sintering was 900°C and the holding time was 130 s.

[0046] And the diamond bit prepared in Comparative Example 2 was made into a coring thin-wall wet drill bit.

Comparative Example 3

[0047] A diamond bit was prepared according to Example 5 except that the temperature of the hot press sintering was 900°C and the holding time was 110 s.

[0048] And the diamond bit prepared in Comparative Example 3 was made into a coring thin-wall wet drill bit.

Comparative Example 4

[0049] A diamond bit was prepared according to Example 6 except that the temperature of the pressureless sintering was 860°C and the holding time was 20 min.

[0050] And the diamond bit prepared in Comparative Example 4 was made into a diamond road cutting saw blade.

Comparative Example 5

[0051] A diamond bit was prepared according to Example 6 except that the temperature of the pressureless sintering was 1000°C and the holding time was 70 min.

[0052] And the diamond bit prepared in Comparative Example 5 was made into a diamond road cutting saw blade.

Comparative Example 6

[0053] A diamond bit was prepared according to Example 6 except that the temperature of the pressureless sintering was 1000°C and the holding time was 50 min.

[0054] And the diamond bit prepared in Comparative Example 6 was made into a diamond road cutting saw blade.

Test Analysis:

1. SEM diagram analysis

[0055] The diamond bit prepared in Example 5 was subjected to SEM analysis and the results are shown in FIG. 1. According to FIG. 1, the diamond is firmly encapsulated by the pure iron-based matrix.

2. Performance testing of the sintered pure iron-based matrixes

[0056] The sintered pure iron-based matrixes of the above examples and comparative examples were subject to performance testing in terms of density, hardness, bending resistance and efficiency of space filling, and the results are shown in Table 1.

Table 1. Performance testing of the sintered pure iron-based matrixes of the examples and comparative examples

Group	Sintering process	Density (g/cm^3)	Hardness (HRB)	Bending strength (Mpa)	Efficiency of space filling	Diamond bit application scenario	Life
Example 1	Hot press sintering temperature 700°C	7.71	98	1280	98.1	Floor grinding block	9000-12000 m^2 (granite)
Example 2	Hot press sintering temperature 700°C	7.74	97	1310	98.5%	Coring thin-wall wet drill bit	30-50 m (concrete C35)
Example 3	Hot press sintering temperature 860°C	7.67	85	904	97.8%	saw blade for cutting road	5000-8000 m (concrete C35)
Example 4	Hot press sintering temperature 765 °C	7.65	87	1023.5	97.3%	front grinding wheel for ceramics	160-220h (polished brick)
Example 5	Hot press sintering temperature 750°C	7.61	96.5	1221.7	96.8%	Coring thin-wall wet drill bit	See Table 2
Example 6	Pressureless sintering temperature 920°C	7.24	70.5	781.7	92.1%	saw blade for cutting road	3500-5000m (concrete C35)
Example 7	Hot press sintering temperature 780°C	7.44	80.1	834.2	94.7%	grinding block for ceramic (46#) 30 pieces/m, 800*800mm	40h
Example 8	Hot press sintering temperature 780°C	7.52	86.7	912.5	95.7%	grinding block for floor	-6000-9000m^2 (granite)
Example 9	Hot press sintering temperature 810°C	7.64	77.3	876.2	97.2%	grinding block for floor	5000-7000 m^2 (granite)
Example 10	Hot press sintering temperature 780°C	7.61	82.6	975.0	96.72%	Coring thin-wall wet drill bit	See Table 2
Example 11	Pressureless sintering temperature 960°C	7.11	62.6	775.0	90.45%	bited blade for cutting granite (105mm)	60-90 m (medium hard granite)
Example 12	Hot press sintering temperature 800°C	7.61	84.6	1011.0	96.72%	Coring thin-wall wet drill bit	30-40 m (concrete C35)
Example 13	Pressureless sintering temperature 900°C	7.32	73.2	820.0	94.2%	grinding block for floor	4000-5000 m^2 (granite)
Comparative example 1	Hot press sintering at 640°C	7.23	69.1	634.2	91.98%	Coring thin-wall wet drill bit	10-20 m (concrete C35)

(continued)

Group	Sintering process	Density (g/cm^3)	Hardness (HRB)	Bending strength (Mpa)	Efficiency of space filling	Diamond bit application scenario	Life
Comparative example 2	Hot press sintering at 900°C	7.57	67.2	631	96.31%	Coring thin-wall wet drill bit	20-35 m (concrete C35)
Comparative example 3	Hot press sintering at 900°C	7.48	64.3	598	95.17%	Coring thin-wall wet drill bit	20-25 m (concrete C35)
Comparative example 4	Pressureless sintering at 860°C	6.89	39.5	241.1	87.66%	saw blade for cutting road	Unable to cut, no strength of bit
Comparative example 5	Pressureless sintering at 1000°C	7.43	53.8	654.2	94.52%	saw blade for cutting road	Unable to cut, too low hardness of bit
Comparative example 6	Pressureless sintering at 1000°C	7.32	43.8	612.9	93.13%	saw blade for cutting road	Unable to cut, too low hardness of bit

[0057] The coring thin-wall wet drill bits made of the diamond bits prepared in Examples 5 and 10 were subjected to performance testing, and the results are shown in Table 2:

Table 2. Performance testing of the coring thin-wall wet drill bits made of the diamond bits

Group		Test item	Result
Example 5	Basic dimensions	Bit length (mm)	20
		Diameter of wet drill bit (mm)	63
		Bit hardness (HRB)	75, 78, 80
		Matrix thickness (mm)	2.45
	Performance testing	Drilling object	C35 concrete, screw-thread steel
		Dimension (mm)	Concrete: 220, screw-thread steel: diameter 18
		Drilling mode	Wet drilling
		Drilling times	30
		Dimension before drilling (mm)	9
		Dimension after drilling (mm)	4.4
		Wear (mm)	4.6
		Duration per time (s)	230-420
Example 10	Basic dimensions	Bit length (mm)	20
		Diameter of wet drill bit (mm)	63
		Bit hardness (HRB)	70, 72, 75
		Matrix thickness (mm)	2.45
	Performance testing	Drilling object	C35 concrete, screw-thread steel
		Dimension (mm)	Concrete: 220 Screw-thread steel: diameter 18
		Drilling mode	Wet drilling
		Drilling times	20
		Dimension before drilling (mm)	9
		Dimension after drilling (mm)	4.2-6.1
		Wear (mm)	2.9-4.8
		Duration per time (s)	250-420

(continued)

Group		Test item	Result
Commercially available conventional Fe-Cu-Ni-Sn matrix	Basic dimensions	Bit length (mm)	20
		Diameter of wet drill bit (mm)	63
		Bit hardness (HRB)	90, 92, 91.5
		Matrix thickness (mm)	2.45
	Performance testing	Drilling object	C35 concrete, screw-thread steel
		Dimension (mm)	Concrete: 220 Screw-thread steel: diameter 18
		Drilling mode	Wet drilling
		Drilling times	20
		Dimension before drilling (mm)	9
		Dimension after drilling (mm)	3.9-4.5
		Wear (mm)	4.5-5.1
		Duration per time (s)	250-450

[0058] According to Table 2, the wear of the diamond bits made of the pure iron-based matrixes was comparable to or less than the diamond bits made of commercially available conventional Fe-Cu-Ni-Sn matrixes, breaking through the conventional thinking of researchers that some additives are added to improve the performance of the iron-based matrix.

[0059] In summary, the present invention solves the technical shortcomings of the prior art. In the present invention, the iron powder in the pure iron-based matrix is fined and the particle size of the iron powder is averagely granulated to 1-25 μm, which shorten movement distance of iron ions, greatly enhances activity of the iron powder, is beneficial to improving hardness and strength of the diamond bit, and can increase a holding power and wear resistance to the diamond. In addition, the diamond bit is sintered at a low temperature, which controls reaction rate of the iron powder and the diamond, so that the iron powder can form a chemical bond with the diamond without excessive carbonization of the diamond which affect the strength thereof, thereby obtaining the diamond bits with excellent comprehensive performance and low price in different application scenarios.

[0060] Although the present invention has been described with reference to the foregoing embodiments, it should be noted that those of ordinary skill in the art can make several improvements and modifications without departing from the principles of the present invention, and such modifications and modifications shall be construed to fall into the scope of the present invention.

Claims

1. A method for preparing a diamond bit from a pure iron-based matrix, wherein the diamond bit is made by combining the pure iron-based matrix with diamond, the method comprises the following steps:

   step S1: mechanically mixing iron powder and diamond and fully mixing to obtain a mixture, wherein a mass fraction of the iron powder with an average particle size of 1-25 μm is ≥ 40%, and an oxygen content of the iron powder with the average particle size of 1-25 μm is 2000-7000 ppm; and a volume of the diamond is 25-30% of a volume of the iron powder; and
   step S2: hot press sintering the mixture obtained in the step S1 for forming and cooling to obtain the diamond bit; wherein a temperature of the hot press sintering is 700-860°C, a holding time is 90-120 s, and a pressure of the hot press sintering is 200-400 kgf/cm^2.

2. The method for preparing a diamond bit from a pure iron-based matrix according to claim 1, wherein in the step S1,

the diamond is wetted with a wetting agent and then mechanically mixed with the iron powder; and wherein the wetting agent is a motor oil or paraffin.

3. The method for preparing a diamond bit from a pure iron-based matrix according to claim 1, wherein in the step S1, a binder with a mass of 1.2-2.2% of a mass of the iron powder is added to be mechanically mixed with the diamond and the iron powder; and wherein the binder is polyethylene glycol or polyvinyl alcohol.

4. A method for preparing a diamond bit from a pure iron-based matrix, wherein the diamond bit is made by combining the pure iron-based matrix with diamond, the method comprises the following steps:

step C1: mechanically mixing iron powder and diamond and fully mixing to obtain a mixture, wherein a mass fraction of the iron powder with an average particle size of 1-25 μm is ≥ 40%, and an oxygen content of the iron powder with the average particle size of 1-25 μm is 2000-7000 ppm; and a volume of the diamond is 25-30% of a volume of the iron powder;
step C2: preparing the mixture obtained in the step C1 into a body with a density of 3.95-6.29 g/cm^3; and
step C3: forming the body obtained in the step C2 by pressureless sintering and cooling to obtain the diamond bit; wherein a temperature of the pressureless sintering is 900-960°C, and a holding time is 30-60 min.

5. The method for preparing a diamond bit from a pure iron-based matrix according to claim 4, wherein in the step C1, the diamond is wetted with a wetting agent and then mechanically mixed with the iron powder; and wherein the wetting agent is a motor oil or paraffin.

6. The method for preparing a diamond bit from a pure iron-based matrix according to claim 4, wherein in the step C1, a binder with a mass of 1.2-2.2% of a mass of the iron powder is added to be mechanically mixed with the diamond and the iron powder; and wherein the binder is polyethylene glycol or polyvinyl alcohol.

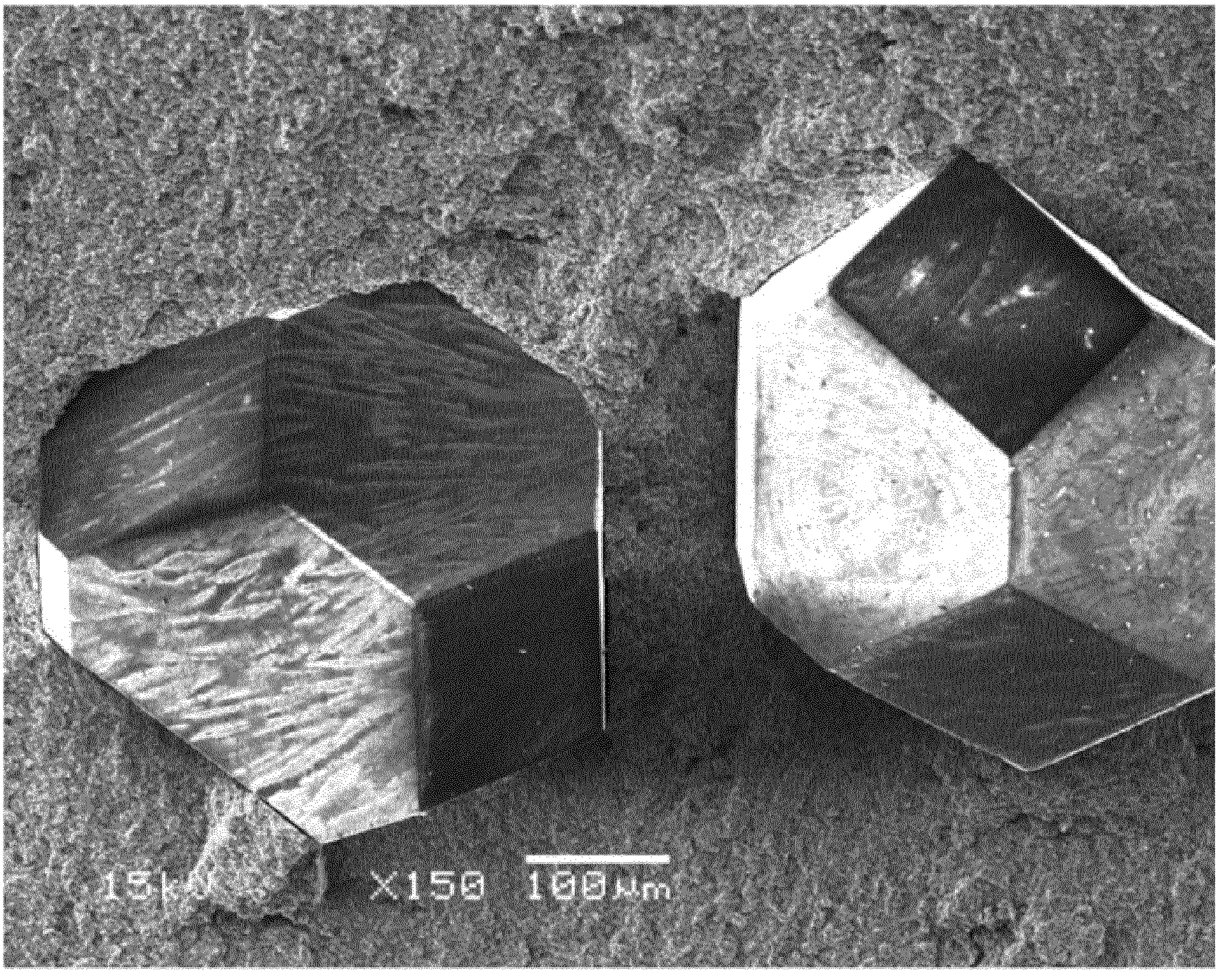

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/117464

A. CLASSIFICATION OF SUBJECT MATTER

C22C 26/00(2006.01)i； C22C 33/02(2006.01)i； B22F 3/14(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C; B22F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; DWPI; SIPOABS; CNKI; CNTXT; USTXT; WOTXT; EPTXT; ISI_Web of Science: 金刚石, 刀头, 胎体, 铁粉, 热压烧结, 润湿剂, 机油, 石蜡, 粘结剂, 聚乙二醇, 聚乙烯醇, 无压烧结, 坯体, diamond, bit, matrix, iron powder, hot pressing sintering, wetting agent, motor oil, paraffin, binder, polyethylene glycol, polyvinyl alcohol, pressureless sintering, body

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 111961938 A (CHENGDU SHIJIAHUANJING TECHNOLOGY CO., LTD.) 20 November 2020 (2020-11-20) claims 1-9	1-6
X	CN 111267010 A (SHANGHAI GANLAN PRECISION TOOL CO., LTD.) 12 June 2020 (2020-06-12) description paragraphs 4, 5, 12-17	1-6
Y	CN 102350501 A (MONTE-BIANCO DIAMOND APPLICATIONS CO., LTD.) 15 February 2012 (2012-02-15) description paragraphs 3, 8-22	1-6
Y	李立刚 等 (LI, Ligang et al.). "化学法制备超细铁粉在金刚石工具中的应用趋势 (The Application Trend of Ultrafine Iron Powder Prepared by Chemical Method in Diamond Tools)" *超硬材料工程 (Superhard Material Engineering),* Vol. 28, No. 2, 30 April 2016 (2016-04-30), ISSN: 1673-1433, page 6, left column, line 3 to page 9, right column, line 2	1-6

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2021	**25 November 2021**

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/117464

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 109986082 A (JIANGSU YOUHE TOOL MANUFACTURER CO., LTD.) 09 July 2019 (2019-07-09) entire document	1-6
A	CN 108274004 A (HUBEI LITTLE ANT DIAMOND TOOLS CO., LTD.) 13 July 2018 (2018-07-13) entire document	1-6
A	CN 104399985 A (KING-STRONG MATERIAL ENGINEERING CO., LTD.) 11 March 2015 (2015-03-11) entire document	1-6

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/117464

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 111961938 A	20 November 2020	None	
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CN 102350501 A	15 February 2012	None	
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REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **GAO YA.** *Influence of Ni and Sn on Structure and Properties of Fe-based Diamond Tool Matrix [D]. China Academy of Machinery Science & Technology,* 2018 **[0002]**