Appeal decision

Appeal No. 2017-18023

Hokkaido, Japan
Appellant SUISO GIJUTSU OYO KAIHATSU CO., LTD.

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Appellant Clean Planet Inc.

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The case of appeal against the examiner's decision of refusal of Japanese Patent Application No. 2015-527347, entitled "Heat-generating Device" (the application internationally published on January 22, 2015, International Publication No. 2015/008859) has resulted in the following appeal decision:

Conclusion

The appeal of the case was groundless.

Reason

No. 1 History of the procedures was originally filed on July 18, 2014 (the dates of priority claim Japanese Patent Application No. 2013-148987 July 18, 2013, Japanese Patent Application No. 2014-53445 March 17, 2014) as an International Patent Application, and the history of the procedures is as follows.

As of May 18, 2016	: Notification of reasons for refusal
July 25, 2016	: Interview
September 23, 2016	: Submission of written opinion and written amendment
December 28, 2016	: Submission of written statement and certificate of experimental results
As of February 22, 2017	: Notification of reasons for refusal (final reasons for refusal)
June 26, 2017	: Submission of written opinion and written amendment
As of August 29, 2017	: Examiner's decision of refusal (delivered on September 5, 2017)
December 5, 2017	: Submission of written request for appeal and written amendment

(The written request for appeal was amended by a written amendment (formality) submitted on January 17, 2018.)

No. 2 Propriety of amendment by the written amendment submitted on December 5, 2017

1 Contents of amendment by the written amendment submitted on December 5, 2017

The amendment by the written amendment submitted on December 5, 2017 (hereinafter, referred to as "the Amendment") aims at deleting Claims 3 and 4 among Claims 1 to 4 of the scope of claims amended by the written amendment submitted on June 26, 2017 (hereinafter, referred to as "before the Amendment").

2 Propriety of amendment

Therefore, the Amendment aims at the deletion of claims as prescribed in Article 17-2(5)(i) of the Patent Act and stipulated in Article 36(5) of the Patent Act.

Thus, the Amendment is legitimate.

No. 3 The Invention

The invention relating to Claims 1 and 2 of the application is specified by the matters described in Claims 1 and 2 of the scope of claims after the Amendment, and the invention relating to Claim 1 among them is as follows.

"[Claim 1]

A heat-generating device comprising:

a reactor in which a deuterium gas or a protium gas is supplied in the reactor kept in a vacuum state;

one wound type reactant which is disposed in the reactor and has a structure in which a thin wire made from Pd is spirally wound around a supporting part;

another wound type reactant which is disposed in the reactor opposite the one wound type reactant, and has a structure in which a thin wire made from Pd is spirally wound around a shaft portion;

a cylindrical reactant which is formed in a reticulated shape by a thin wire made from Ni that is different in kind from the Pd of the thin wire, is disposed along an inner wall so as to cover the inner wall in the reactor, and surrounds the one wound type reactant and the other wound type reactant;

a gas supply pipe which supplies the deuterium gas or the protium gas into the reactor; and

a heater which heats the inside of the reactor, wherein

the wound type reactant and the other wound type reactant function as electrodes;

a surface of the thin wire on the one wound type reactant, a surface of the thin wire on the other wound type reactant, and a surface of the reactant are respectively in a state where an oxide layer is removed, and have structures provided with a plurality of metal nanoparticles having a nano-size of 1000 [nm] or smaller; and

the reactor generates excess heat that is at a heating temperature or more by executing heating by the heater and the supply of the deuterium gas or the protium gas into the reactor." (hereinafter, referred to as "the Invention".)

No. 4 Reasons for refusal stated in the examiner's decision

Reasons of notice of reasons for refusal issued on February 22, 2017 are as outlined below.

Referring now to the specification and drawings, the Invention is a heat-generating device or a heat-generating method which generates heat while generating neutrons, so that it still relates to a so-called cold nuclear fusion technology when viewed from a person skilled in the art. However, no confirmation has been obtained

about the generation of excess heat by a nuclear fusion reaction at normal temperature, nor has confirmation been obtained about atomic conversion by a nuclear reaction or the associated generation of neutrons or excess heat, and according to the detailed description of the Invention in the specification, the generation of excess heat or neutrons cannot be confirmed, so that the detailed description of the Invention is not clear and sufficient to enable a person skilled in the art to carry out the Invention.

Then, although the applicant submitted a certificate of experimental results and its supplement statement as the written statement dated December 28, 2016, the confirmation about the generation of excess heat by a nuclear fusion reaction at normal temperature, and atomic conversion by a nuclear reaction or the associated generation of neutrons or excess heat, cannot be obtained even with the certificate of experimental results.

Therefore, the detailed description of the Invention does not satisfy the requirement of Article 36(4)(i) of the Patent Act.

No. 5 Judgment by the body

1 Detailed description of the Invention

The following descriptions are described in the detailed description of the Invention. (Underlines were applied by the body; the same shall apply hereafter.)

(1) Problem to be solved by the invention

"[0002]

A collaborative research team of professor Fleischmann and professor Pons announced that the team had succeeded in causing a nuclear fusion reaction at room temperature in 1989 (refer to Non Patent Document 1, for instance). According to this announcement, a cold nuclear fusion reaction which causes a nuclear fusion reaction at room temperature is a phenomenon in which when heavy water is electrolyzed with the use of a Pd electrode or a Ti electrode as a cathode and a Pt electrode as an anode, heat is generated which is equal to or more than a heat that is generated by the electrolysis, and simultaneously γ-rays and neutrons can be observed. Such a cold nuclear fusion reaction generates unusually excess heat in the reaction time, and accordingly, if this exothermic phenomenon can be controlled, this exothermic phenomenon can be used also as a heat source of the heat-generating device.

...(omitted)...

[0004]

However, actually, as for such a cold nuclear fusion reaction, the mechanism is not elucidated, the reproducibility is also poor, and the exothermic phenomenon cannot stably occur. Because of this, when it is intended to use such a cold nuclear fusion reaction as the heat source of the heat-generating device, there has been a problem that the probability of occurrence of the exothermic phenomenon is very low and the cold nuclear fusion reaction cannot stably generate heat.

Then, the present invention is designed with respect to the above described problem, and is directed at providing a reactant, a heat-generating device, and a heat-generating method, which can generate heat more stably than conventionally possible."

(2) Means for solving the problem

[0006]

A heat-generating device as set forth in Claim 1 of the present invention includes: a reactor in which a deuterium gas or a protium gas is supplied in the reactor kept in a vacuum state; one wound type reactant which is disposed in the reactor and has a structure in which a thin wire made from Pd is spirally wound around a supporting part; another wound type reactant which is disposed in the reactor opposite the one wound type reactant, and has a structure in which a thin wire made from Pd is spirally wound around a shaft portion; a cylindrical reactant which is formed in a reticulated shape by a thin wire made from Ni that is different in kind from the Pd of the thin wire, is disposed along an inner wall so as to cover the inner wall in the reactor, and surrounds the one wound type reactant and the other wound type reactant; a gas supply pipe which supplies the deuterium gas or the protium gas into the reactor; and a heater which heats the inside of the reactor, wherein the wound type reactant and the other wound type reactant function as electrodes; a surface of the thin wire on the one wound type reactant, a surface of the thin wire on the other wound type reactant, and a surface of the reactant are respectively in a state where an oxide layer is removed, and have structures provided with a plurality of metal nanoparticles having a nano-size of 1000 [nm] or smaller; and the reactor kept in a vacuum state generates excess heat that is at a heating temperature or more by executing heating by the heater and the supply of the deuterium gas or the protium gas into the reactor."

(3) Effect of the invention
"[0008]

According to Claim 1 of the invention, hydrogen atoms are occluded in the metal nano-protrusions of the reactant, electrons in the metal nano-protrusions act as heavy electrons by being strongly influenced by surrounding metal atoms and/or other electrons, and as a result, an internuclear distance between the hydrogen atoms in the metal nano-protrusion is diminished, whereby the probability at which a tunnel nuclear fusion reaction occurs can be raised, and thus, heat can be generated more stably than conventionally possible."

(4) Description of Embodiments
A First embodiment
"[0011]
(1) First Embodiment (1-1)

Whole structure of heat-generating device according to first embodiment. In Fig. 1, reference numeral 1 denotes a heat-generating device according to a first embodiment, has a wound type reactant 25 and a reactant 26 provided in a reactor 2 as an electrode pair, and is configured so as to cause a nuclear fusion reaction at room temperature in the reactor 2, and thereby be capable of generating heat. In the case of this embodiment, in the reactor 2, a tubular heat transporting pipe 32 is spirally wound along an outer wall of the reactor 2. In the inside of the heat transporting pipe 32, a fluid such as water flows from a supply port 32a towards a discharge port 32b, and the fluid flowing in the heat transporting pipe 32 is heated by heat generated in the reactor, and the heated fluid is discharged from the discharge port 32b in the state. The fluid is sent to, for instance, an illustrated electric power plant and the like, and the heat of the fluid can be used for power generation and the like.
[0012]

Here, a gas supply unit 3 is provided in the reactor 2, and a deuterium gas (purity of 99.99%) can be supplied into the reactor from the gas supply unit 3 through a gas supply pipe 8, as a reactant gas. The gas supply unit 3 has a deuterium gas cylinder 5 and a gas receiver 6, stores the high-pressure deuterium gas which has been discharged from the deuterium gas cylinder 5 in the gas receiver 6, then decompresses the deuterium gas to approximately 1 atmosphere, and can supply the decompressed deuterium gas into the reactor 2. Here, in the gas supply pipe 8, an open/close valve 7 is provided, and a pressure measuring unit 15 is also provided through a branch portion 16. In the reactor 2, the opening and closing and the amount of the opening and closing of the open/close valve 7 are controlled, and thereby the amount of supply of the deuterium gas into the reactor can be controlled. The pressure measuring unit 15 which is provided in the gas supply pipe 8 can measure a pressure in the gas supply pipe 8, and can send pressure measurement data obtained by the measurement to a logger 17, as a pressure in the reactor 2.

[0013]

In addition, an evacuation unit 10 is provided in the reactor 2 through an evacuation pipe 13. In the reactor 2, a gas in the reactor is exhausted to the outside by the evacuation unit 10, the inside of the reactor can become a vacuum atmosphere, an open/close valve 11 which is provided on the evacuation pipe 13 is closed, and the inside of the reactor can be held in a vacuum state. At this time, the deuterium gas is supplied into the reactor 2 from the gas supply unit 3, and thereby the reactor can assume such a state that the inside of the reactor kept in a vacuum state is filled with the deuterium gas.

[0014]

Incidentally, in the reactor 2, a thermocouple 18 for measuring the temperature of the reactor 2 is provided on the outer wall surface of the reactor 2. In addition, a neutron measuring unit 19 which measures neutrons that is radiated from the reactor 2 is arranged outside of the reactor 2. These thermocouple 18 and neutron measuring unit 19 are connected to the logger 17, and the logger 17 collects the measurement data of the temperature obtained from the thermocouple 18, the measurement data of the neutrons obtained from the neutron measuring unit 19, and besides the measurement data of the pressure obtained from the above described pressure measuring unit 15, and can send out these data to a computer 21. The computer 21 is configured so as to display these data collected through the logger 17 onto a display, for instance, and to be capable of making an operator grasp the state in the reactor 2 on the basis of the data.

[0015]

Here, the reactor 2 has a cylindrical portion 2a which is formed, for instance, from stainless steel (SUS306 or SUS316) and the like, and wall parts 2b and 2c which are similarly formed from stainless steel (SUS306 or SUS316) and the like; the opening portions of both ends of the cylindrical portion 2a are blocked by the wall parts 2b and 2c through a gasket (not shown); and an enclosed space can be formed by the cylindrical portion 2a and the wall parts 2b and 2c. In the case of this embodiment, the cylindrical portion 2a has an opening portion 29 drilled on the side face part, and one end of an opening visual recognition portion 30 is bonded to the side face part so that a hollow region of the cylindrical opening visual recognition portion 30 which is formed, for instance, of stainless steel (SUS306 and SUS316) and the like communicates with the opening portion 29. This opening visual recognition portion 30 has a window

portion 31 fitted in the other end, which is formed of transparent members such as Kovar-glass, and is structured so that the operator can directly visually recognize the state in the reactor 2 from the window portion 31 through the hollow region and the opening portion 29, while maintaining the sealed state in the reactor. Incidentally, in the case of this embodiment, in the reactor 2, the cylindrical portion 2a is formed to be a cylindrical shape, a whole length (between the wall parts 2b and 2c) is selected to be 300 [mm], and an outer diameter of the cylindrical portion 2a is selected to be 110 [mm], for instance.

[0016]

In addition to this structure, in the inside of this reactor 2, the electrode pair formed of the wound type reactant 25 and the reactant 26 is arranged, and is configured so as to be capable of generating plasma by a glow discharge which is generated by the electrode pair. Practically, in the reactor 2, one wall part 2b has an opening portion 28 drilled therein, a wound type reactant having a rod shape is inserted in the opening portion 28, and the wound type reactant 25 can be arranged in the reactor. Practically, in the wall part 2b, an insulating member 27 which is provided in the opening portion 28 blocks the opening portion 28, also holds the wound type reactant 25 by the insulating member 27 so that the wound type reactant 25 does not come in contact with the opening portion 28, and electrically insulates the wound type reactant 25 from the reactor 2, while maintaining the hermetically-closed state in the reactor 2.

[0017]

In the case of this embodiment, one end of the wound type reactant 25 is exposed from the opening portion 28 of the wall part 2b to the outside of the reactor 2, an electric power source 20 is connected to the one end through a wire 22a, and voltage can be applied from the electric power source 20. This electric power source 20 has further another wire 22b, the wire 22b is connected to the wall part 2b of the reactor 2, and voltage can be applied also to the reactor 2. This electric power source 20 is connected to the computer 21 through the logger 17, an output voltage and the like are collected by the logger 17, the collected voltage is sent out to the computer 21, and the output voltage and the like are controlled by the computer 21.

[0018]

In addition to this structure, the reactor 2 has a structure in which the reactant 26 is arranged so as to come in contact with the inner wall surface of the cylindrical portion 2a, and can apply a voltage supplied from the electric power source 20 to the reactant 26 through the cylindrical portion 2a. Thereby, the wound type reactant 25 and the reactant 26 can generate the glow discharge in the reactor 2, due to the voltage which is applied from the electric power source 20.

[0019]

Practically, in the case of this embodiment, the reactant 26 is formed from a hydrogen storage metal which includes, for instance, any of Ni, Pd, Pt, Ti, and an alloy containing at least any one element of these elements so as to be a cylindrical shape, is arranged along the inner wall of the reactor 2, and can be installed so that the outer surface covers the inner wall of the cylindrical portion 2a of the reactor 2. The reactant 26 is structured so as to cover the inner wall of the cylindrical portion 2a in the reactor 2, and thereby be capable of suppressing an occurrence that elements (for instance, in case of cylindrical portion 2a of stainless steel, elements such as iron, light elements, oxygen, nitrogen, and carbon) are emitted from the inside of the cylindrical

portion 2a into the reactor, by irradiation of the cylindrical portion 2a with electrons, when the plasma is generated by the electrode pair.

[0020]

In addition to the structure, this reactant 26 has a reticulated shape formed of a thin wire on the surface, further has a plurality of metal nanoparticles (not shown) having a nano-size with a width of 1000 [nm] or smaller formed on the surface of the thin wire, and the surface is formed to become an uneven state. In the reactant 26, when the plasma is generated by the glow discharge in the deuterium gas atmosphere in the reactor by the wound type reactant 25 and the reactant 26 (in an exothermic reaction process which will be described later), the surface oxide layer is desirably removed by the plasma treatment and the like beforehand so that hydrogen atoms (deuterium atoms) can be occluded in the metal nanoparticles, and the surface metal nanoparticles desirably assume an activated state.

[0021]

Here, in the present invention, the plurality of metal nanoparticles having the nano-size are formed on the surface of the reactant 26 which works as an electrode; and thereby, when the glow discharge is generated in the deuterium gas atmosphere by the wound type reactant 25 and the reactant 26, hydrogen atoms are occluded in the metal nanoparticles, and electrons in the nano-sized metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, an internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, and a nuclear fusion reaction can be caused which generates heat while emitting neutrons in the reactor 2.

[0022]

Incidentally, in this embodiment, after the reactant 26 has been installed in the reactor 2, a plurality of metal nanoparticles having the nano-size are formed on the surface of the reactant 26, by submitted subjected to plasma treatment which will be described later, but the present invention is not limited to this. It is also acceptable to form a plurality of metal nanoparticles having the nano-size on the surface of the reactant 26 beforehand, by performing a sputtering treatment, an etching treatment, or the like on the reactant 26, before the reactant 26 is installed in the reactor 2, and to install the reactant 26 which has the metal nanoparticles formed on the surface, in the reactor 2. However, even in this case, it is necessary to perform the plasma treatment which will be described later, remove the surface oxide layer of the reactant 26, and convert the metal nanoparticles on the surface into an activated state so that hydrogen atoms can be occluded in the metal nanoparticles when the plasma due to the glow discharge has been generated in the reactor by the wound type reactant 25 and the reactant 26 in the deuterium gas atmosphere.

[0023]

Practically, on the surface of the reactant 26, a plurality of metal nanoparticles are formed which have a curved surface and show such a shape that a part of a spherical particle, an elliptical particle, or an egg-shaped particle is embedded (for instance, hemispherical shape, half-elliptic shape, or half-egg shape) in the surface. In addition, in the case of this embodiment, on the surface of the reactant 26, metal nanoparticles are formed so as to come in contact with each other, and a plurality of metal nanoparticles are formed so as to be densely packed. In addition, among the metal nanoparticles, there is even a metal nanoparticle which has a fine metal nanoparticle with a width

(particle diameter) of 1 to 10 [nm] further formed on the curved surface of the metal nanoparticle, and the uneven surface which has a plurality of metal nanoparticles thereon can be formed so as to be dotted with the fine metal nanoparticles having a width of 1 to 10 [nm].

[0024]

Such a metal nanoparticle is formed desirably so as to have a nano-size with the width of 1000 [nm] or smaller, preferably 300 [nm] or smaller, more preferably 10 [nm] or smaller, and further preferably 5 [nm] or smaller. When the width of the metal nanoparticle is reduced, it can facilitate occurrence of the nuclear fusion reaction in the reactor 2 by a small amount of the deuterium gas to be supplied.

[0025]

Here, the size of such a metal nanoparticle has been further theoretically analyzed with the use of the theoretical calculation which shows the probability of the occurrence of the nuclear fusion reaction, and the width (particle diameter) of the metal nanoparticle is most preferably 1 to 10 [nm]; and the fine metal nanoparticles are desirably formed so as to be spaced at such a distance that the fine metal nanoparticles do not come in contact with each other by thermal movement, preferably at a distance of 3 or more times the particle diameter. In this case, it is preferable that the surface of the reactant 26 has the fine metal nanoparticles of, for instance, 4×0^{8} per 1 [cm2] formed thereon, which have a width (particle diameter) of 1 to 10 [nm], while being dotted with the fine metal nanoparticles.

[0026]

In the case of this embodiment, when the thickness of the reactant 26 exceeds 1.0 [mm], the nano-sized fine metal nanoparticles resist being formed on the surface, and accordingly in order that the nano-sized metal nanoparticles are formed on the surface, it is desirable that the thickness is 1.0 [mm] or less, more preferably 0.3 [mm] or less, and further preferably 0.1 [mm] or less. In addition, in the case of this embodiment, the reactant 26 is formed of the thin wire to have a reticulated shape, accordingly can form the thickness thin easily with the use of a thin wire having a small diameter, and can also increase the surface area of the surface on which the metal nanoparticles are formed. As for the surface of the reactant 26, a width of one block of the net is desirably selected to be 10 to 30 [mm].

[0027]

As shown in Fig. 2, the wound type reactant 25 which constitutes the electrode pair together with the reactant 26 has a structure in which a thin wire 36 which is formed from a hydrogen storage metal, for instance, including any of Pt, Ni, Pd, Ti and an alloy containing at least one element among the elements is spirally wound around a perimeter of a shaft part 35 which is a supporting part and is similarly formed from the hydrogen storage metal including Pt, Ni, Pd, Ti or the alloy containing at least one element among the elements, and the shaft part 35 is arranged on the central axis of the cylindrical portion 2a. In addition, a distance between the wound type reactant 25 and the reactant 26 can be selected to be 10 to 50 [mm]. In the case of this embodiment, the wound type reactant 25 is formed of the shaft part 35 which has a diameter of 3 [mm] and a length of 200 [mm] and is formed from Ni, and of the thin wire 36 which has a diameter of 1.0 [mm] and is formed from Pt, and the distance between the thin wire 36 and the reactant 26 is selected to be 50 [mm].

[0028]

Incidentally, in the above described embodiment, the surface of the reactant 26 receives attention, and the case is described where a plurality of metal nanoparticles having the nano-size are formed on the surface of the reactant 26, but such a plurality of metal nanoparticles having the nano-size are formed also on the thin wire 36 of the wound type reactant 25. Practically, in the case of this embodiment, the wound type reactant 25 is formed from a hydrogen storage metal, and accordingly the plurality of metal nanoparticles having the nano-size are formed on the surface of thin wire 36. Thereby, when the plasma is generated by the wound type reactant 25 and the reactant 26 in the deuterium gas atmosphere, hydrogen atoms are occluded also in the metal nanoparticle of the wound reactant 25, and the electrons (free electron) in the nano-sized metal nanoparticle are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, an internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, and there can be caused the nuclear fusion reaction which generates heat while emitting neutrons in the reactor 2.

[0029]

(1-2) Plasma treatment

Here, the heat-generating device 1 of the present invention is configured to be capable of forming a plurality of metal nanoparticles having the nano-size on the surface of the above described reactant 26 and wound type reactant 25, and also performing plasma treatment which activates the surfaces of the reactant 26 and the wound type reactant 25. Practically, when the reactant and the wound type reactant which do not have the metal nanoparticles formed on the surface are provided in the reactor 2, for instance, the heat-generating device 1 firstly evacuates a gas in the reactor 2 which is an enclosed space, and then sets a pressure in the reactor at 10 to 500 [Pa] (for instance, approximately 100 [Pa]), as the plasma treatment.

[0030]

In this state, the heat-generating device 1 sets the wound type reactant 25 as an anode, sets the reactant 26 as a cathode, and applies a voltage of 600 to 1000 [V] (for instance, approximately 1000 [V]) to the electrode pair, causes the glow discharge, and generates the plasma in the reactor 2. In this case, the temperature of the reactant 26 which has been set as the cathode can rise to 500 to 600 [°C], for instance. The heat-generating device 1 continuously causes the glow discharge for 600 seconds to 100 hours (preferably 10 hours or more) in such a vacuum atmosphere, and thereby can form a plurality of metal nanoparticles having the nano-size on the surfaces of the reactant 26 and the wound type reactant 25, can remove the oxide layer on the surfaces of these reactants 26 and the wound type reactant 25, and can activate the surfaces.

[0031]

Incidentally, the plasma treatment may generate the plasma not only by setting the wound type reactant 25 as the anode and setting the reactant 26 as the cathode, as has been described above, but also may subsequently generate the plasma after that, by reversing polarities of the wound type reactant 25 and the reactant 26, setting the wound type reactant 25 as the cathode and the reactant 26 as the anode. Thus, also when the glow discharge is caused by the wound type reactant set as the cathode and the reactant 26 set as the anode, it is desirable to apply the voltage of 600 to 1000 [V] (for instance, approximately 1000 [V]) to the electrode pair, and to continuously cause the glow discharge for 600 seconds to 100 hours (preferably 10 hours or more). Thereby, in both of the wound type reactant 25 set as the cathode and the reactant 26 set as the

anode, temperatures rise, for instance, to 500 to 600 [°C], and the surfaces can be surely activated.

[0032]

The heat-generating device 1 desirably performs heating treatment on the wound type reactant 25 and the reactant 26, after having performed the above described plasma treatment. This heating treatment can make the wound type reactant 25 and the reactant 26 emit protium, H_2O, and a hydrocarbon gas, for instance, by directly heating the wound type reactant 25 and the reactant 26 with a heater, and can facilitate hydrogen atoms to be occluded. Such heating treatment is desirably performed until the wound type reactant 25 and the reactant 26 no longer emit protium, H_2O, and the hydrocarbon gas, and is desirably performed at 100 to 200 [°C] for 3 hours or longer, for instance.

[0033]

Here, if the surface of the reactant 26 has been previously submitted to acid pickling treatment of immersing a metal in aqua regia or mixed acid at room temperature for several minutes, before the metal nanoparticles are formed thereon, remarkably finer metal nanoparticles can be formed on the surface at the time of the plasma treatment.

[0034] (1-3) Exothermic reaction process

Subsequently, the heat-generating device 1 can perform an exothermic reaction process which causes a nuclear fusion reaction in the reactor 2, by using the reactant 26 which has such a plurality of metal nanoparticles having the nano-size formed on the surface. In the case of this embodiment, in the heat-generating device 1, sequentially to the above described plasma treatment, the deuterium gas can be supplied into the reactor 2 by the gas supply unit 3, while the inside of reactor 2 is kept in the vacuum state, as the exothermic reaction process.

[0035]

Subsequently, in the reactor 2 which comes to have the deuterium gas atmosphere, the heat-generating device 1 can generate the plasma, by applying a voltage of 400 to 1500 [V], preferably 600 to 1000 [V], more preferably 700 to 800 [V] to the wound type reactant 25 and the reactant 26, and causing the glow discharge in the electrode pair. Thereby, while the heat-generating device 1 generates the plasma in the reactor 2, hydrogen atoms are occluded in the metal nanoparticles on the surfaces of the wound type reactant 25 and the reactant 26, and the nuclear fusion reaction can occur.

[0036]

Here, in the heat-generating device 1 of the present invention, when the plasma is generated in the reactor 2 in the exothermic reaction process, the nuclear fusion reaction occurs in the reactor 2, but at this time, a fine metal nanoparticle is newly formed on the surfaces of the reactant 26 and the wound type reactant 25, hydrogen atoms are occluded also in the metal nanoparticle which is newly formed, and a nuclear fusion reaction can occur.

[0037]

(1-4) Outline of nuclear fusion reaction in heat-generating device according to the present invention

Here, the reactant 26 shall receive attention, and such an outline will be briefly described below that the nuclear fusion reaction occurs easily by virtue of formation, on the surface of the reactant 26, of a plurality of metal nanoparticles having the nano-size. Generally, a neutron and the like are not radiated and heat is not generated by irradiation

of metal with electrons. However, in the metal nanoparticle having a certain size or smaller as the nano-size, an electron acts as a heavy fermion (heavy electron), makes hydrogen atoms approach each other, and causes the nuclear fusion reaction. Usually, in the case of deuterium, an energy of 10^7 K=lkeV or more is required in order to cause the nuclear fusion reaction. In order to give such large energy by temperature, in the case of deuterium, for instance, a high temperature of approximately 10^7 K or higher is required, and in the case of light hydrogen, a high temperature of approximately 1.5×10^7 K or higher is required; and a probability of occurrence of the nuclear fusion is as extremely low as 10^{-31}/s/atom pair.

[0038]

However, when a plurality of metal nanoparticles (metal nano-protrusion) having the nano-size are formed on the surface of the reactant 26 as in the present invention, an electron is strongly influenced by the surrounding metal atom or another electron in the metal nanoparticle. Specifically, when hydrogen atoms are introduced into the metal nanoparticle, a concentration of hydrogen in the metal nanoparticle increases, and when the concentration of hydrogen increases, the property of the electron in the metal nanoparticle further changes, and a mass of the electron becomes a large value. The heavy electron forms hydrogen nuclei and atoms, and when the heavy electron becomes an extranuclear electron, a radius of an electron orbit shrinks, and the internuclear distance between heavy electron hydrogen atoms also shrinks. As a result, the probability of the occurrence of the nuclear fusion reaction between the heavy electron hydrogen atoms increases due to the tunnel effect in the reactant 26, and occurrence of the nuclear fusion reaction is facilitated. For instance, in the case of the metal nanoparticle formed from Pd, when the mass of an electron increases two-fold, the probability of the occurrence of the nuclear fusion reaction due to the tunnel effect increases by 10 orders of magnitude, and occurrence of the nuclear fusion reaction can be facilitated.

[0039]

The reactant 26 may have atoms of, for instance, an alkaline group or an alkaline earth group (for instance, Li, Na, K, Ca, and the like which have hydrogen atom structure) attached to the surface of the metal nanoparticle, in order to increase the probability of the occurrence of the nuclear fusion reaction between the heavy electron hydrogen atoms. Thereby, a transfer action of the electron in the metal nanoparticle can be drastically increased, and the probability of the occurrence of the nuclear fusion reaction can be further increased. The heat-generating device 1 of the present invention stably causes the nuclear fusion reaction in this way, and can stably generate heat by the large energy which is generated in the nuclear fusion reaction.

[0040]

(1-5) Verification test

Next, the heat-generating device 1 as shown in Fig. 1 was prepared, and the above described plasma treatment and exothermic reaction process were performed, and the neutrons were measured in the perimeter of the reactor 2 along with a temperature of the reactor 2. Here, firstly, a reactant formed from Ni (purity of 99.9%) which did not have a plurality of metal nanoparticles having the nano-size formed thereon was prepared, and the reactant was installed in the reactor 2. Subsequently, in order that the plasma treatment was performed, the inside of the reactor 2 was evacuated by the

evacuation unit 10, and a pressure in the reactor 2 was controlled to approximately 10^{-6} atmospheres.

[0041]

Subsequently, a voltage of 1 [kV] was applied to the wound type reactant 25 and the reactant 26 in this state to have generated the glow discharge, and generation of the glow discharge was continued in the reactor 2 for 30 hours. After that, at this time point, the reactant 26 was taken out from the reactor 2. When the surface state of the reactant 26 was checked with an SEM photograph and the like, it was confirmed that a plurality of metal nanoparticles having the nano-size with a particle diameter of 1000 [nm] or smaller were densely formed and the surface became uneven.

[0042]

Aside from the above reactant, in order to perform the exothermic reaction process, the reactant 26 was left in the reactor 2, 1 [kV] was applied to the electrode pair as described above, and generation of the glow discharge was continued. Then, the pressure in the reactor 2 was set at approximately 10^{-6} atmospheres, and the deuterium gas was supplied to the reactor 2 at a gas pressure of 10^{-2} atmospheres, by the gas supply unit 3. Thereby, in the heat-generating device 1, the neutrons were measured after 1 to 2 minutes, with the neutron measuring unit 19.

[0043]

Subsequently, the glow discharge was once stopped, and after the deuterium gas was supplied into the reactor 2, the electrode pair was fully cooled. Then, the voltage of 1 [kV] was applied to the electrode pair again, and the glow discharge was generated. Thereby, the neutron measuring unit 19 started to measure the neutrons again, and after this, measured the neutrons continuously for several hours. Here, the measurement result of the - 20 neutron is shown in Fig. 3. As shown in Fig. 3, in this heat-generating device 1, the neutron was generated suddenly after the voltage was supplied to an electrode pair in order to cause the glow discharge, and accordingly it could be estimated that the nuclear fusion reaction accompanied by the generation of the neutron occurred in the reactor 2. It was also confirmed that the number of such neutrons to be generated could be controlled by a discharge voltage of the electrode pair, and the number of the neutrons to be generated increased exponentially with the voltage. The neutrons were stably generated by the supply of the voltage, and 10^6 neutrons were obtained. The amount of the neutrons generated per unit area of the reactant 26 when the exothermic reaction was continued for 200 seconds was calculated, and found to be 10^5 neutrons.

[0044]

In addition, the temperature of the reactor 2 was measured with the thermocouple 18 at the same time when the neutrons were measured, and a result shown in Fig. 4 was obtained. From Fig. 4, it was confirmed that the temperature of the reactor 2 rose after the neutron was generated, and it was confirmed from the above that this heat-generating device 1 could generate heat from the reactor 2. The reason why the temperature rise was measured behind the generation of the neutron is that the area in which heat was generated deviated from the place at which the thermocouple 18 was set, and because a delay occurred in the temperature rise by a period needed for the thermal conduction. In Fig. 4, ATl to AT5 show the spots which were provided at predetermined spaces along the cylindrical portion 2a of the reactor 2. Incidentally, the electric current which flowed in the electrode pair at this time was 30 [mA]. In

other words, electric power became 30 [W]. The amount of heat generated by the above input became 1 [kW], and the heating value with respect to the input reached 33 fold.

[0045]

(1-6) Operation and Effect

In the above configuration, in the heat-generating device 1 according to the present invention, the reactant 26 was provided in the reactor 2, which had a plurality of metal nanoparticles formed on the surface, which had each the nano-size of 1000 [nm] or smaller and were formed from a hydrogen storage metal; and an exothermic reaction process was performed which generated the plasma by the wound type reactant 25 and the reactant 26 in the reactor 2 that came to have the deuterium gas atmosphere, and gave energy. Thereby, in the heat-generating device 1, hydrogen atoms are occluded in the metal nanoparticle of the reactant 26; and the electrons in the metal nanoparticle are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, and the probability of causing the tunnel nuclear fusion reaction can be raised.

[0046]

In addition, in the heat-generating device 1, even when the reactant which does not have the metal nanoparticle formed on the surface is provided in the reactor 2, before being subjected to the exothermic reaction process, the inside of the reactor 2 is set at a vacuum atmosphere, and the plasma treatment generating the plasma in the reactor 2 by the glow discharge that occurs due to the wound type reactant 25 and the reactant is performed, and thereby the reactant 26 can have a plurality of metal nanoparticles having the nano-size formed on the surface. Furthermore, in the heat-generating device 1, the plasma treatment is performed prior to the exothermic reaction process, whereby the oxide layer on the surface of the reactant 26 can be removed. Thus, the surface of the reactant 26 can be converted into an activated state in which hydrogen atoms can be occluded in the metal nanoparticle of the reactant 26 in the exothermic reaction process, and the nuclear fusion reaction can be caused.

[0047]

In addition, in the case of this embodiment, the reactant 26 is formed of the thin wire to have a reticulated shape, and accordingly can easily make the thickness of the surface thin only by reducing the diameter of the thin wire, and can also control the thickness of the surface at such optimal thinness that a plurality of metal nanoparticles having the nano-size are easily formed on the surface. Furthermore, in the reactant 26, the surface is formed to have the reticulated shape, and thereby the surface area can be increased. Correspondingly, there can be widened a region on which the metal nanoparticles that occlude hydrogen atoms therein are formed, and the reaction spots in which heat is generated can be increased.

[0048]

In addition, the heat-generating device 1 is structured so that the voltage is applied to the reactor 2 from the electric power source 20 through the wire 22b, and at the same time, the reactant 26 is brought into contact with the inner wall of the reactor 2, and the inner wall of the reactor 2 is covered by the reactant 26. Thereby, the reactant 26 works as an electrode, and at the same time, the reactant 26 can prevent the inner wall of the reactor 2 from being ground by electron irradiation due to glow discharge.

[0049]

Furthermore, the heat-generating device 1 is structured so that a plurality of metal nanoparticles having the nano-size were formed also on the surface of the thin wire 36 of the wound type reactant 25, which is formed from the hydrogen storage metal. Thereby, in the heat-generating device 1, hydrogen atoms are occluded also in the metal nanoparticle on the surface of the thin wire 36 of the wound type reactant 25; and the electrons in the metal nanoparticle are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, and the probability of causing the tunnel nuclear fusion reaction can be raised.

[0050]

According to the above structure, the reactant 26 that has a plurality of metal nanoparticles (metal nano protrusions) formed on the surface, each of which has the nano-size of 1000 [nm] or smaller and is formed from a hydrogen storage metal, is structured to be installed in the reactor that comes to have the deuterium gas atmosphere. Thereby, hydrogen atoms are occluded in the metal nanoparticle of the reactant 26; and the electrons in the metal nanoparticle are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus heat can be generated more stable than conventionally possible."

B Second embodiment

"[0051]

(2) Second embodiment

(2-1) Structure of heat-generating device according to second embodiment

In Fig. 5 in which the portions corresponding to those in Fig. 1 are denoted by the same reference numerals and are shown, reference numeral 41 shows a heat-generating device according to a second embodiment which is different from the first embodiment in the structure of a reactor 42 and a structure of the electrode pair. In addition, this heat-generating device 41 according to the second embodiment is different from the above described heat-generating device according to the first embodiment, in a point that in the exothermic reaction process, the inside of the reactor 42 is heated by a heater without generating plasma therein by the electrode pair, the deuterium gas is supplied into the heated reactor 42, and thereby excess heat equal to or greater than the heating temperature is generated. Furthermore, the second embodiment is different from the first embodiment also in the point that in this heat-generating device 41, when the plasma is generated by the electrode pair after generation of the excess heat, the exothermic temperature further rises, and the heat of the high temperature due to the temperature rise can be continued to be generated as long as the deuterium gas is supplied into the reactor 42, even if the plasma is stopped.

[0052]

As for the other structures, this heat-generating device 41 has the same structure as that in the above described first embodiment, and accordingly the illustration and the description of the gas supply unit 3, the evacuation unit 10, the electric power source 20, and the like will be omitted. Practically, in the case of this embodiment, the reactor 42 includes a cylindrical portion 43a which is formed from, for

instance, stainless steel (SUS306 or SUS316) and the like, and wall parts 43b and 43c, wherein opening portions of both ends of the cylindrical portion 43a are blocked by the wall parts 43b and 43c through a gasket (not shown), and the cylindrical portion 43a and the wall parts 43b and 43c can form an enclosed space.

[0053]

In this case, in the cylindrical portion 43a, another opening portion 45 is drilled on the side face part so as to face the opening portion 29 in which the opening visual recognition portion 30 is provided, and one end of a cylindrical pipe communicating portion 46 which is formed of, for instance, stainless steel (SUS306 - 25 and SUS316) or the like is bonded to the side face part so that a hollow region of the pipe communicating portion 46 communicates with the opening portion 45. A wall part 47 is provided in the other end of the pipe communicating portion 46; and the gas supply pipe 8, the evacuation pipe 13, and a pipe 48 for measuring a pressure are provided in the wall part 47 so that the insides of pipes of the gas supply pipe 8, the evacuation pipe 13, and the pipe 48 for measuring the pressure communicate with the inside of the reactor 42. The pressure measuring unit 15 is provided through the pipe 48 for measuring the pressure, and can measure the pressure in the reactor 42 through the pipe 48 for measuring the pressure.

[0054]

In addition to this structure, in the inside of the reactor 42, an electrode pair formed of wound type reactants 50 and 51 is provided, and the reactant 26 is further provided so as to cover the inner wall of the cylindrical portion 43a of the reactor 42. In the case of this embodiment, the wound type reactants 50 and 51 are arranged in the reactor so as to face opening portions 29 and 45 which are drilled in the cylindrical portion 43a, and are structured so that the deuterium gas sent from the pipe communicating portion 46 which is provided in the opening portion 45 can be sprayed directly to the wound type reactants 50 and 51, and also the operator can directly recognize the state of the wound type reactants 50 and 51 visually from the hollow region of the opening visual recognition portion 30 which is provided in the opening portion 29.

[0055]

Here, in the case of this embodiment, the heat-generating device 41 is different from the heat-generating device in the above described first embodiment, and is structured as follows: the reactant 26 does not work as the electrode; the wound type reactants 50 and 51 which are provided in the reactor 42 aside from the reactant 26 work as a cathode and an anode; and when the plasma treatment is performed, these wound type reactants 50 and 51 cause the glow discharge while working as the electrode pair, and can generate the plasma in the reactor. The reactant 26 has a structure similar to that in the above described first embodiment, and although not working as the electrode, has a plurality of metal nanoparticles having the nano-size formed on the surface, by the plasma treatment which uses the wound type reactants 50 and 51 as the electrode pair. (Here, the plasma treatment unit is to evacuate gas in the reactor 42 which has been controlled to an enclosed space, set the pressure in the reactor to 10 to 500 [Pa], apply a voltage of 600 to 1000 [V] to an electrode pair, cause the glow discharge for 600 seconds to 100 hours, and thereby raise the temperature of the reactant 26 to 500 to 600 [°C].) Thereby, when the deuterium gas is supplied after the reactant has been heated

by a heater, in the reactor 42 in which the vacuum state is kept, the metal nanoparticles can occlude hydrogen atoms and the nuclear fusion reaction can occur.

[0056]

The wound type reactant 50 is provided at a tip end of an electrode holding portion 54, and can be arranged in the center of the reactor 42 by the electrode holding portion 54. The electrode holding portion 54 is connected to an electric power source not shown through an electrode introduction part 57, and can apply the voltage applied from the electric power source to the wound type reactant 50. The electrode holding portion 54 is inserted into the reactor 42 from the opening portion 55 which is drilled in the wall part 43b, is held by the insulating member 56 which is provided on the opening portion 55, and also is arranged so as not to come in contact with the wall part 43b due to the insulating member 56 in the opening portion 55, and is electrically insulated from the reactor 42. The wound type reactant 50 has a structure in which a thin wire 53 formed from a hydrogen storage metal which includes, for instance, any of Pd, Ti, Pt, Ni, and an alloy containing at least any one element of these elements is spirally wound around a supporting part 52 which is formed of a conducting member of Al_2O_3 (alumina ceramics) and the like, and a plurality of metal nanoparticles having the nano-size can be formed on the surface of the thin wire 53 by the plasma treatment. Thereby, also on the wound type reactant 50, hydrogen atoms are occluded in these metal nanoparticles, when the wound type reactant 50 is heated by a heater in the reactor 42 in which the vacuum state is kept, and also the deuterium gas is supplied, and the nuclear fusion reaction can occur.

[0057]

The size and the shape of the metal nanoparticle formed on the surface of the thin wire 53 in the wound type reactant 50 are the same as those of the metal nanoparticle formed on the surface of the reactant 26. Specifically, on the surface of the thin wire 53 on the wound type reactant 50, a plurality of metal nanoparticles can be formed which have a curved surface and show such a shape that a part of a spherical particle, an elliptical particle, or an egg-shaped particle is embedded (for instance, hemispherical shape, half elliptic shape, or half-egg shape) in the surface.

[0058]

Incidentally, when the reactant 26 was formed from Ni and the thin wire 53 on the wound type reactant 50 was formed from Pd, the metal nanoparticles were formed so as to come in contact with each other on the surface of the thin wire 53 on the wound type reactant 50, although the number was not so many as that of the reactant 26 formed from Ni, and a region in which a plurality of metal nanoparticles were densely packed was also formed (shown in Fig. 8 which will be described later). In addition, it is desirable that the metal nanoparticles which are formed on the surface of the thin wire 53 on the wound type reactant 50 are formed so as to have the nano-size with a width of 1000 [nm] or smaller, preferably 300 [nm] or smaller, more preferably 10 [nm] or smaller, and further preferably 5 [nm] or smaller, similarly to the metal nanoparticles which are formed on the surface of the reactant 26. When the width of the metal nanoparticle is reduced, occurrence of the nuclear fusion reaction by a small amount of the deuterium gas to be supplied can be facilitated.

[0059]

Even in this case, the metal nanoparticles having a width (particle diameter) of 1 to 10 [nm] are desirably formed on the surface of the thin wire 53 on the wound type

reactant 50, similarly to the surface of the reactant 26, while such a distance that the fine metal nanoparticles do not come in contact with each other by a thermal movement, or preferably a distance of 3 times or more of the particle diameter is provided among the fine metal nanoparticles. In this case, the metal nanoparticles of, for instance, 4×10^8 per 1 [cm^2] are preferably formed on the surface of the reactant, and are desirably formed so as to be dotted with further fine metal nanoparticles.

[0060]

In the reactor 42, a thermocouple 58 is arranged so as to come in contact with the supporting part 52 of the wound type reactant 50. Thereby, the wound type reactant 50 is structured so that the temperature is measured with the thermocouple 58 and an operator can check the temperature by a computer or the like, which is connected to thermocouple 58. In this case, the thermocouple 58 has such a structure that a K type thermocouple element is inserted in the inside of an alumina pipe, is held by an insulating member 59 in the wall part 43b, and is insulated from the reactor 42.

[0061]

The wound type reactant 51 of the other side, which forms a pair with the wound type reactant 50, is provided on the tip end of an electrode holding portion 62, and is arranged in the reactor so as to face one wound type reactant 50 by the electrode holding portion 62. The electrode holding portion 62 is connected to an electrode introduction part 64 held by an insulating member 63 which is provided in the wall part 43b. The electrode introduction part 64 is connected to the electric power source not shown, and can apply a voltage applied from the electric power source to the wound type reactant 51 through the electrode holding portion 62. Thereby, the wound type reactant 51 can work as the cathode or the anode, when the voltage is applied from the electric power source.

[0062]

The wound type reactant 51 has a structure in which a thin wire 61 that is formed from a hydrogen storage metal which includes, for instance, any of Pd, Ti, Pt, Ni, and an alloy containing at least one element among the elements is spirally wound on a shaft part 60 that is similarly formed from the hydrogen storage metal which includes any of Pd, Ti, Pt, Ni, and the alloy containing at least one element among the elements, and the basal portion of the shaft part 60 is attached to the tip end of the electrode holding portion 62. As for this wound type reactant 51 as well, a plurality of metal nanoparticles having the nano-size can be formed on the surface of the shaft part 60 and the thin wire 61 by the plasma treatment, similarly to the above described wound type reactant 50. Thus, also on the wound type reactant 51, hydrogen atoms are occluded in the metal nanoparticles formed on the surfaces of the shaft part 60 and the thin wire 61, when the deuterium gas is supplied into the reactor 42 in which the vacuum state is kept, and the nuclear fusion reaction can occur. The metal nanoparticles formed on the surfaces of the shaft part 60 and the thin wire 61 of the wound type reactant 51 have the same structure as the above described metal nanoparticles formed on the surface of the thin wire 53 of the wound type reactant 50, and the description shall be omitted here.

[0063]

Thus, the heat-generating device 41 according to the second embodiment is structured as follows: a plurality of metal nanoparticles having the nano-size can be formed on the surfaces of the wound type reactant 50 and 51 and the reactant 26 by the

plasma treatment; subsequently, when the deuterium gas is supplied to the inside of the reactor 42 in which the vacuum state is kept, in such a state that the wound type reactants 50 and 51 and the reactant 26 are heated by a heater not shown, hydrogen atoms are occluded in the metal nanoparticles on the surfaces of the wound type reactants 50 and 51 and the reactant 26; and as a result, a nuclear fusion reaction occurs in the reactor 42, and heat can be generated. Here, the heating temperature at which the wound type reactants 50 and 51 and the reactant 26 are heated by a heater is desirably 200 [°C] or higher, further preferably 250 [°C] or higher.

[0064]

In addition, in the heat-generating device 41 according to this second embodiment, if the glow discharge is caused by the electrode pair and the plasma is generated at such a time when heat is generated in the reactor 42, the exothermic temperature rises further; and even if the plasma is stopped, the reactor 42 can continue to keep the state in which the temperature has risen, as long as the inside of the reactor 42 is kept at the deuterium gas atmosphere.

[0065]

(2-2) Verification test

Next, a verification test was performed with the use of the heat-generating device 41 shown in Fig. 5, in order to check whether or not the reactor 42 generated heat. Here, the reactor 42 having a volume of 15 [l] and a weight of 50 [kg] was formed from stainless steel (SUS306). In addition, in this verification test, there was used the wound type reactant 50 which had the thin wire 53 that had a diameter of 0.1 [mm] and a length of 1000 [mm] and was formed from Pd (99.9% purity) wound 15 times, around the supporting part 52 that had a width of 30 [mm] and a thickness of 2 [mm] and was formed from Al_2O_3 (alumina ceramics); along with the wound type reactant 51 which had the thin wire 61 that had a diameter of 1 [mm] and a length of 300 [mm] and was formed from Pd (99.9% purity) and spirally wound without any gap, around the shaft part 60 that had a diameter of 3 [mm] and a length of 50 [mm] and was formed from Pd (purity of 99.9%). In addition, in this verification test, there was used the cylindrical reactant 26 of which surface was formed in a reticulated shape by the thin wire that had a diameter of 0.1 [mm] and was formed from Ni (purity of 99.9%).

[0066]

Subsequently, these wound type reactants 50 and 51 and the reactant 26 were cleaned ultrasonically with an alcohol and acetone, and were installed in the reactor 42 while having kept the cleaned state so that contamination with oil did not occur. The whole of this reactor 42 is set at the ground potential. In addition, a K type and stainless steel cover type of a thermocouple which had a diameter of 1.6 [mm] and a length of 300 [mm] was used as the thermocouple 58 for directly measuring the temperature of the wound type reactant 50; the outside of the outer coating of the stainless steel was further insulated by an alumina pipe having a diameter of 3 [mm] and a length of 100 [mm]; and the tip end portion was brought into contact with the surface of the wound type reactant 50.

[0067]

Then, first of all, as the plasma treatment, gas in the reactor 42 was gradually evacuated, the inside of the reactor 42 was controlled to a vacuum atmosphere of several Pa, then the wound type reactant 50 was set at the anode, the direct current voltage of 600 [V] was applied, and the electric discharge was generated by

approximately 20 [mA], for approximately 600 seconds. Next, the electrode voltage was changed, the wound type reactant 50 was set at the cathode, the direct current voltage of 600 [V] was applied, and the electric discharge was generated by approximately 20 [mA], for approximately 1200 seconds. This process was repeated 5 times, then the reactant 26 and the wound type reactant 50 were taken out from the reactor 42, and the surface was observed with an SEM photograph.

[0068]

Here, Fig. 6A is a SEM photograph showing the surface of the reactant 26, which was imaged before being submitted to the above described plasma treatment. It could be confirmed that a plurality of metal nanoparticles having the nano-size with a width of 1000 [nm] or smaller were not formed on the surface, and that the surface was flat. On the other hand, Fig. 7 is an SEM photograph showing the surface of the reactant 26, which was imaged after having been submitted to the above described plasma treatment. It could be confirmed that a plurality of metal nanoparticles having the nano-size with the width of 1000 [nm] or smaller were formed on the surface, and that the surface became uneven. In addition, it could be confirmed that these metal nanoparticles had curved surfaces such as a hemispherical shape and a half elliptic shape.

[0069]

In addition, Fig. 6B is an SEM photograph showing the surface of the thin wire 53 on the wound type reactant 50, which was imaged before being submitted to the above described plasma treatment. It could be confirmed that a plurality of metal nanoparticles having the nano-size with a width of 1000 [nm] or smaller were not formed on the surface also on the wound type reactant 50, and that the surface was flat. On the other hand, Fig. 8 is an SEM photograph showing the surface of the thin wire 53 on the wound type reactant 50, which was imaged after having been submitted to the above described plasma treatment. It could be confirmed that a plurality of metal nanoparticles having the nano-size with the width of 1000 [nm] or smaller were formed on the surface, and that the surface became uneven. In addition, also in this case, it could be confirmed that the metal nanoparticles had curved surfaces such as the hemispherical shape and the half-elliptic shape. It was confirmed that the metal nanoparticles were formed so as to come in contact with each other on the surface of the thin wire 53 on the wound type reactant 50, although the number was not so many as that of the reactant 26, and that a region in which a plurality of metal nanoparticles were densely packed was also formed.

[0070]

Here, the surface of the thin wire 53 on the wound type reactant 50 after the plasma treatment was further expanded and observed, and as a result, SEM photographs as shown in Fig. 9A and Fig. 9B were obtained. It could be confirmed from Fig. 9A and Fig. 9B that the metal nanoparticle having width of 100 [nm] or smaller was formed, fine metal nanoparticles having further small width were formed on the surface of the metal nanoparticle, and as in the case or the like, the surface was formed to be the uneven shape. Incidentally, in this verification test, the wound type reactant 50 which had the thin wire 53 of Pd with a diameter of 0.1 [mm] wound around the supporting part 52 was used, but when the verification test was performed with the use of the wound type reactant which had a thin wire of Pd with a diameter of 1 [mm] wound around the supporting part 52, it could be confirmed that when the electric discharge

was continued for 10 [ks], and this operation was repeated 10 times, sufficiently active metal nanoparticles could be formed on the surface of the thin wire.

[0071]

Subsequently, in this verification test, the inside of the reactor 42 was kept at the vacuum state; the wound type reactants 50 and 51 and the reactant 26 were heated at 100 to 200 [°C] for about 3 hours by a heater not shown, and were activated; protium, H_2O, and hydrocarbon-based gases were emitted from the wound type reactants 50 and 51 and the reactant 26; and impurities were removed therefrom.

[0072]

Subsequently, as for the exothermic reaction process, in the verification test of the heat-generating device 41 according to the second embodiment, as shown in Fig. 10 and Fig. 11, the wound type reactant 50 was heated in stages while the vacuum state in the reactor 42 was kept, and when the room temperature difference reached 140 [°C], the deuterium gas was introduced at 100 [Pa] from the gas supply pipe 8 into the reactor 42. Here, Fig. 10 shows the voltage applied to the electrode pair, and Fig. 11 shows the temperature of the wound type reactant 50 starting from the time when the wound type reactant 50 was heated by the heater in stages. The temperature shown in Fig. 11 is a difference (room temperature difference) between the temperature of the wound type reactant 50 and room temperature.

[0073]

In this verification test, as shown in Fig. 11, the wound type reactant 50 was heated to the room temperature difference of 140 [°C] in stages, and then the deuterium gas was supplied into the reactor 42 at 100 [Pa] (in other words, 100 [ml]). As a result, the room temperature difference immediately rose up to 220 [°C], although the plasma was not generated by the electrode pair. After that, as shown in Fig. 10 and Fig. 11, the voltage value to be applied to an electrode pair was raised to 45 [V], and the activation treatment was performed by the plasma for 4000 seconds, in order to activate the surface of the thin wire 53 (referred to as thin wire of Pd in Fig. 10) of the wound type reactant 50. As a result, the temperature further rose by 30 [°C] and became 250°C. After that, the voltage value to be applied to the electrode pair was lowered to 32 [V], and the plasma was stopped, but the state of the risen temperature stably continued until the deuterium gas was discharged from the reactor 42.

[0074]

In addition, at this time, the neutrons in the periphery of the reactor 42 were measured by the neutron measuring unit, and as a result, the neutrons were measured in the neutron measuring unit from the time when the deuterium gas was introduced into the reactor 42 and the wound type reactant 50 began to generate heat. Thus, it can be estimated from the heat generation in the wound type reactant 50 and the measurement of the neutrons that the nuclear fusion reaction occurs in the reactor 42. Incidentally, as shown in Fig. 10 and Fig. 11, after the reactor came to the state of stably generating heat at 250 [°C], voltage was applied to the electrode pair to cause the glow discharge, and the activation treatment by the plasma was performed, in order to activate the surface of the thin wire 53 of the wound type reactant 50 again. However, further temperature rise could not be confirmed. From the above verification tests, it could be confirmed that in the heat-generating device 41 according to the second embodiment, the nuclear fusion reaction is caused and heat can be generated by an operation of: forming a plurality of metal nanoparticles having the nano-size on the surface of the

wound type reactants 50 and 51 and the reactant 26; activating the resultant surface; and then supplying the deuterium gas into the reactor 42.

[0075]

(2-3) Operation and Effect

In the above structure, also in the heat-generating device 41 according to the present invention, the reactant 26 was provided in the reactor 42, which was formed from a hydrogen storage metal and had a plurality of metal nanoparticles having the nano-size formed on the surface, and the reactant 26 was heated with a heater to receive energy, the deuterium gas was supplied into the reactor 42 which was kept at the vacuum state, and the inside of the reactor 42 was controlled to the deuterium gas atmosphere. In addition, the heat-generating device 41 was structured so that a plurality of metal nanoparticles having the nano-size were formed also on the surfaces of the thin wire 53 of the wound type reactant 50, which was formed from the hydrogen storage metal, and of the wound type reactant 51. Thereby, in the heat-generating device 41, when energy is given by heating with the heater, hydrogen atoms are occluded in the metal nanoparticles of the wound type reactants 50 and 51 and the reactant 26; and the electrons in the metal nanoparticle are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus, the heat equal to or more than a heating temperature can be generated more stably than conventionally possible.

[0076]

In addition, in this heat-generating device 41, when the plasma is generated by the electrode pair in the reactor to become a deuterium gas atmosphere, heat generation is promoted and the exothermic temperature further rises; and even if the plasma is stopped, the reactor 42 can continue to keep the state in which the temperature has risen, as long as the inside of the reactor 42 is kept at the deuterium gas atmosphere.

[0077]

In addition, in the heat-generating device 41, the wound type reactant 51 is further provided in addition to the reactant 26 and the wound type reactant 50, a plurality of metal nanoparticles are formed also on this wound type reactant 51, accordingly the regions in which the metal nanoparticles are formed increase, correspondingly hydrogen atoms become easily occluded in the metal nanoparticle, and the probability at which the nuclear fusion reaction occurs can be enhanced."

C Third embodiment

"[0078]

(3) Third embodiment

In Fig. 12 in which the portions corresponding to those in Fig. 1 are denoted by the same reference numerals and are shown, reference numeral 65 denotes a heat-generating device according to a third embodiment which is different from the above described first embodiment in the structure of the electrode pair that is installed in the reactor 2. Practically, in the reactor 2 in the present heat-generating device 65, a wound type reactant 66 which works, for instance, as an anode, and an inside reactant 72 which works as a cathode are arranged in series along the central axis of the reactor 2, and these wound type reactant 66 and the inside reactant 72 are arranged in a hollow region of the cylindrical reactant 26 which similarly works as the cathode.

...(omitted)...
[0085]

In addition, the heat-generating device 65 has been structured so that a plurality of metal nanoparticles having the nano-size are formed also on the surfaces of the shaft part 69 and the thin wires 68 and 70 of the wound type reactant 66, which are formed from the hydrogen storage metal. Thereby, in the heat-generating device 65, when energy is given by heating with the heater, hydrogen atoms are occluded also in the metal nanoparticles on the surfaces of the shaft part 69 and the thin wires 68 and 70; and the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus heat can be generated more stably than conventionally possible."

D Verification test by using deuterium gas, and protium gas
(A) "[0091]
(4-1) About use of heavy water gas, protium gas, and light water gas
...(omitted)...
[0093]

In addition, also in the heat-generating device 41 (Fig. 5) according to the second embodiment, the reactant 26 which is formed from the hydrogen storage metal and has a plurality of metal nanoparticles having the nano-size formed on the surface, and the wound type reactants 50 and 51 are installed in the reactor 42; the reactant 26 and the wound type reactants 50 and 51 are heated with a heater to receive energy; and the heavy water gas, the protium gas, or the light water gas is supplied into the reactor 42 which is kept at the vacuum state. Thereby, also in the heat-generating device 41, the hydrogen atoms are occluded in the wound type reactants 50 and 51 and the metal nanoparticles of the reactant 26; and the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus, the heat equal to or more than a heating temperature can be generated more stably than conventionally possible.
[0094]

Furthermore, also in the heat-generating device 41 according to the second embodiment, which uses the heavy water gas, the protium gas, or the light water gas, when the plasma is generated by the electrode pair in the reactor 42 which is controlled to the heavy water gas atmosphere, the protium gas atmosphere, or the light water gas atmosphere, after excess heat has been generated, similarly to the above description, heat generation is promoted, and the exothermic temperature further rises; and even if the plasma is stopped, the reactor 42 can continue to keep the state in which the temperature has risen, as long as the inside of the reactor 42 is kept at the heavy water gas atmosphere, the protium gas atmosphere, or the light water gas atmosphere.
...(omitted)...
[0096]

In the reactor 42 having the heavy water gas atmosphere, the protium gas atmosphere, or the light water gas atmosphere therein, the hydrogen atoms are occluded in the metal

nanoparticles of the reactant 26 and the inside reactant 72; the electrons in the metal nanoparticles are strongly influenced by the surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus heat can be generated more stably than conventionally possible.

...(omitted)...

[0098]

(4-2) About the verification test by using deuterium gas, heavy water gas, light water gas, and protium gas

Next, a verification test was performed for examining output total energy and the like, at the time when the heat-generating device 41 having a structure illustrated in Fig. 5 was used, and when the deuterium gas, the heavy water gas, the light water gas and the protium gas were used. Here, as for the heat-generating device 41 which was used for the verification test, the reactant 26 was prepared which was a net of 100 mesh formed by a thin wire that had a diameter of 0.05 [mm] and was formed from Ni (99.9% purity), and had a height of 30 [cm] and a width of 30 [cm], and was installed so that the outer circumferential surface of the reactant 26 came in close contact with the inner wall of the reactor 42. In this stage, a plurality of metal nanoparticles having the nano-size are not formed on the surface of the cylindrical reactant 26.

[0099]

In addition, in this verification test, the wound type reactant 50 was used which had the thin wire 53 that had a diameter of 0.2 [mm] and a length of 1000 [mm] and was formed from Pd (99.9% purity) wound 15 times around the supporting part 52, which had a width of 30 [mm] and a thickness of 2 [mm] and was formed from Al_2O_3 (alumina ceramics). Furthermore, in this verification test, the wound type reactant 51 was used which had the thin wire 61 that had a diameter of 1 [mm] and a length of 300 [mm] and was formed from Pd (99.9% purity) spirally wound without any gap, around the shaft part 60, which had a diameter of 3 [mm] and a length of 50 [mm] and was formed from Pd (purity of 99.9%).

[0100]

Subsequently, these wound type reactants 50 and 51 and the reactant 26 were cleaned ultrasonically with an alcohol and acetone, and were installed in the reactor 42 while having kept the cleaned state so that contamination with oil did not occur. The whole of this reactor 42 is set at the ground potential. In addition, a K type and stainless steel cover type of a thermocouple which had a diameter of 1.6 [mm] and a length of 300 [mm] was used as the thermocouple 58 for directly measuring the temperature of the wound type reactant 50; the outside of the outer coating of the stainless steel was further insulated by an alumina pipe having a diameter of 3 [mm] and a length of 100 [mm]; and the tip end portion was brought into contact with the surface of the wound type reactant 50. In the wound type reactants 50 and 51 which form an electrode pair, the polarity of an anode and a cathode can be changed.

[0101]

Subsequently, first of all, as the plasma treatment, gas in the reactor 42 was evacuated, the inside of the reactor 42 was controlled to a vacuum atmosphere of several Pa, then the wound type reactant 50 was set at the anode, the other wound type reactant 51 was set at the cathode, a direct current voltage of 600 to 800 [V] was applied,

and the electric discharge was generated by approximately 20 [mA], for approximately 600 seconds. Next, the electrode voltage was changed, the wound type reactant 50 was set at the cathode, the other wound type reactant 51 was set at the anode, a direct current voltage of 600 to 800 [V] was applied, and the electric discharge was generated by approximately 20 to 30 [mA] for approximately 10^3 to 10^4 seconds.
[0102]

Subsequently, in the verification test, the inside of the reactor 42 was kept at the vacuum state; and the wound type reactants 50 and 51 and the reactant 26 were heated by an unillustrated heater, and were activated, as the plasma treatment. The wound type reactants 50 and 51 and the reactant 26 were heated until the wound type reactants 50 and 51 and the reactant 26 came not to emit protium, H_2O, and hydrocarbon-based gases. Specifically, the wound type reactants 50 and 51 and the reactant 26 were heated at 100 to 200 [°C] for about 3 hours by a heater, and were activated; protium, H_2O, and hydrocarbon-based gases were emitted from the wound type reactants 50 and 51 and the reactant 26; and impurities were removed therefrom.
[0103]

Furthermore, in this verification test, as the plasma treatment, the wound type reactant 50 was set at the anode, a direct current voltage of 600 to 800 [V] was applied, and the electric discharge was generated by approximately 20 to 30 [mA] for approximately 10 [ks] seconds. Thus, a plurality of metal nanoparticles having the nano-size were formed on the surfaces of the wound type reactants 50 and 51 and the reactant 26. After such plasma treatment, the deuterium gas was supplied into the reactor 42, and the gas pressure in the reactor 42 was examined, and as a result, it was confirmed that the gas pressure decreased to 40 [Pa] from 170 [Pa]. From this, it was confirmed that the wound type reactants 50 and 51 and the reactant 26 which were the sample metal absorbed 6.5 [cm^3] of the deuterium gas.
[0104]

In addition, by using the wound type reactants 50 and 51 and the reactant 26 which had such a plurality of metal nanoparticles having the nano-size formed on the surfaces, the exothermic reaction process was performed, which caused the nuclear fusion reaction in the reactor 42. In the verification test, the exothermic reaction process was performed, while the inside of the reactor 42 was kept at the vacuum state, and the types of gases supplied into the reactor 42 by a gas supply unit 3, the gas pressure at the time when the gas is supplied, and the input heating wattage of the heater which heats the electrode pair were changed; and various numerical values such as the temperature of the reactor 42 were examined. Here, first, a result obtained when the deuterium gas was used as the gas to be supplied into the reactor 42 is shown in the following Table 1.

(B) "[0105]
[Table 1]
...(omitted)...
[0106]

In Table 1, "No" of the first column is a test number, "Gas Pressure Pa" of the second column is a gas pressure (Pa) of the deuterium gas, "Input Watt" of the third column is the input heating wattage (W) of the heater, "Output/W Electrode" of the fourth column is a heat output (W) calculated from the temperature of the electrode

(wound type reactant 50), and "Output/W Reactor" of the fifth column is a heat output (W) calculated from the temperature of the reactor 42.

[0107]

In addition, in Table 1, "Time ks" of the sixth column is excess heat duration time (ks), "Hout/Hin Electrode" of the seventh column is a value of an output/input ratio calculated from the temperature of the electrode (wound type reactant 50), "Hout/Hin Reactor" of the eighth column is an output/input ratio calculated from the temperature of the outer wall of the reactor 42, "Temperature/C Electrode" of the ninth column is a steady temperature (°C) of the electrode (wound type reactant 50) during the test, "Temperature/C Reactor" of the tenth column is a steady temperature (°C) of the reactor 42 during the test, "Input Energy kJ" of the eleventh column is input total energy (kJ), "Output Electrode kJ" of the twelfth column is output total energy (kJ) calculated from the temperature of the electrode (wound type reactant 50), and "Output Reactor kJ" of the thirteenth column is output total energy (kJ) calculated from the temperature of the outer wall of the reactor 42.

[0108]

Test numbers No. 6 to No. 13 show results of a series of tests. It was confirmed from Table 1 that output total energy (the twelfth column and the thirteenth column) larger than the input total energy (the eleventh column) was obtained in any case of having used the deuterium gas, generation of the excess heat could be observed, and the heat could be generated by the heat-generating device 41.

[0109]

Next, in the heat-generating device 41, the gas components were examined before and after the heat generation having occurred when the deuterium gas was used. Fig. 14A is a result of a mass spectrometry of the deuterium gas which is a source gas, and shows the result in which the mass number of the gas M/e is shown on a horizontal axis, and the gas components in the reactor 42 are shown on a vertical axis by a partial pressure. From the value of the partial pressure, a volume 5 [l], a temperature and a pressure of the reactor 42, a gas volume in the normal state of the deuterium gas as shown in Fig. 14A was obtained. As shown in Fig. 14A, the deuterium gas which is a source gas mainly contains deuterium, and the mass number 4 had a partial pressure of 202 [Pa]. In addition, as for other contents, HD^+ with the mass number of 3 had a partial pressure of 42 [Pa], and H_2^+ with the mass number of 2 had 5 [Pa]. As impurities, the mass number 18 which is estimated to be H_2O^+ or OD^+ was included. The mass number 17 is estimated to be OH^+, the mass number 19 to be OHD^+, and the mass number 20 to be OD_2^+.

[0110]

Next, the exothermic reaction process was performed in the heat-generating device 41, and the gas components in the reactor 42 after the exothermic reaction process were examined. Here, in the exothermic reaction process, the electrode (wound type reactant 50) was heated for about 84 [ks] with a heater, while the deuterium gas was supplied into the reactor 42 in the evacuated state. At this time, an input into the heater was set at 46 [W] for the first 7 [ks], and was set at 81 [W] after that. In the meantime, the gas was exhausted from the reactor 42 several times, but excess heat was continuously generated.

[0111]

Fig. 14B shows the result of the examination of the gas components in the reactor 42 for 10 [ks] after the above described exothermic reaction process had been performed (in other words, after the electrode heating with the heater has been completed, and hereafter referred to as after end of test as well). From Fig. 14B, after the end of the test, HD^+ of which mass number is 3 increased, and secondly, H_2^+ of which mass number is 2 and OHD^+ of which mass number is 19 increased.
[0112]

Then, in order to more correctly identify the gas components, the heat generation test was performed in the heat-generating device 41 for 30 days by using the deuterium gas. Fig. 15 and Fig. 16 show the result of the measurement in which the change in the gas components during the test is expressed along the passage of the test time. In Fig. 15 and Fig. 16, a horizontal axis shows the passage of time and a vertical axis shows a gas volume; and Fig. 16 is a graph in which the region of the gas volume 15 [cm^3] or less in Fig. 15 is expanded. "Total exclude 2" in Fig. 15 and Fig. 16 shows the total gas volume. The excess heat was 15 [W] in the minimum value for the input of 80 [W]. If the elapsed time is multiplied by 15 [W], exothermic energy, in other words, joules, is obtained. From the above relation, when the elapsed time is 2.7 [Ms], 40 [MJ] can be obtained from the calculation.
[0113]

As shown in Fig. 15 and Fig. 16, the mass number 4 of which mass number 4 is mainly (D_2^+) decreased immediately after the start of the verification test, and after that, a decreasing speed was lowered, but the mass number 4 linearly decreased with elapsed time. On the other hand, the mass number 2 which was estimated to be a deuterium atom (D^+) increased, which was the reverse of the behavior of the mass number 4 (D2+). The dissociation energy of such a molecule of hydrogen was 436 [kJ/mol] at 25 [°C], and the degree of dissociation was approximately 1.0×10^{-7} at 1000 [°C]. In addition, even if the heating by a heater for the reactant 26 formed from nickel was stopped, gas of the mass stably existed.
[0114]

After the start of the verification test, the mass number 3 increased in reverse correlation to the mass reduction of the mass number 2, but after that, the mass number 3 decreased correspondingly to the behavior of the mass number 4. In addition, the mass number 28 also increased with time and the quantity was 2.3 [cm 3] in 30 days. Other components remained almost unchanged. The total of components other than the mass number 2 was almost constant after the first change. In addition, the mass number 3 (HD^+) and the mass number 4 (D_2^+) (Note for the body: it is recognized as a misprint of the mass number 4 (D_2^+)) both depended on the gas pressure and the output total energy, but the tendencies were in reverse. The mass number 3 increased when the gas pressure and the output total energy increased, but the mass number 4 decreased when the gas pressure and the output total energy increased. These tendencies mean that the mass number 4 contributes to the generation of the mass number 2 and the mass number 3. It has been found from the verification test that as the output total energy is larger, the amount of generated mass number 2 (H_2^+) increases, but does not depend on the gas pressure of the deuterium gas, and on the other hand, that the mass number 3 (HD^+) increases according to the increase of the gas pressure and heating value of the deuterium gas."

(C) "[0119]

Here, the result of the verification test performed in the heat-generating device 41 is shown in the following Table 3, in which the wound type reactants 50 and 51 that became the electrode pair were formed from Pd, and the deuterium gas, the heavy water, gas or the light water gas was used as a source gas to be supplied into the reactor 42.

[0120]

[Table 3]

...(omitted)...

[0121]

In Table 3, "Gas Component Significant" of the second column shows the type of the used gas, "Gas Pressure Pa" of the third column shows the gas pressure at the time when the gas is supplied into the reactor 42, "Power in/W Heat Watt W" of the fourth column shows the input heating wattage (W) by the heater at the time when the wound type reactants 50 and 51 and the reactant 26 are heated, "Power in/W Plasma V" of the fifth column shows the input voltage value at the time when the plasma discharge is generated by the wound type reactants 50 and 51 which become electrodes, "Power in/W Plasma W" of the sixth column shows the input wattage at the time when the plasma discharge is generated by the wound type reactants 50 and 51 which become the electrode pair, and "Power in/W Total" of the seventh column shows all the input wattage in which the heating wattage input by the heater is added to the wattage input into the electrode pair at the time of the plasma discharge.

[0122]

In addition, in Table 3, "Time ks" of the eighth column shows the duration time of the excess heat, "Heat out/W Estimated by Electrode temp" of the ninth column shows the heating value calculated from the temperature of the electrode (wound type reactant 50), "Heat out/W Estimated by reactor temp" of the tenth column shows the heating value calculated from the temperature of the outer wall of the reactor 42, "Hout/Hin Estimated by Electrode temp" of the eleventh column shows an output/input ratio calculated on the basis of the temperature of the electrode (wound type reactant 50), and "Hout/Hin Estimated by reactor temp" of the twelfth column shows an output/input ratio calculated on the basis of the temperature of the outer wall of the reactor 42.

[0123]

In Sample No. 33 using the deuterium gas, the plasma discharge was not performed and the heating for the electrode pair by a heater also was not performed. In this case, it could be confirmed that the excess heat did not occur, from the output/input ratio of the eleventh column and the twelfth column.

[0124]

On the other hand, it could be confirmed that in other samples, the excess heat occurred, from the output/input ratio of the eleventh column and the twelfth column. It could be confirmed that in the heat-generating device 41, the excess heat was generated in the exothermic reaction process when the wound type reactants 50 and 51 and the reactant 26 were heated by a heater, even if not only the deuterium gas but also the heavy water gas or the light water gas was supplied into the reactor 42 to have controlled the inside of the reactor 42 to the heavy water gas atmosphere or the light water gas atmosphere.

(D) [0125]

Next, the result of the verification test at the time when the protium (H_2) gas was used in the heat-generating device 41 is shown in Table 4. In this case, the plasma treatment was performed on the same conditions as those at the time when the wound type reactants 50 and 51 were formed from Ni, the wound type reactants 50 and 51 were set at the electrode pair, and the result of the above described Table 1 was obtained. Subsequently, the exothermic reaction process was performed in the heat-generating device 41, and as a result, the result as shown in Table 4 was obtained.

[0126]

[Table 4]

...(omitted)...

[0127]

In Table 4, the "pressure" of the third column shows the gas pressure (Pa) at the time when the protium gas is supplied into the reactor 42, "input/W" of the fourth column shows the input heating wattage (W) by a heater at the time when the wound type reactants 50 and 51 and the reactant 26 are heated, "Time/ks" of the fifth column shows the duration time of the excess heat, "inside temperature calculation" of the sixth column shows a heating value calculated from the temperature (°C) in the reactor 42, and "reactor temperature calculation" of the seventh column shows a heating value calculated from the temperature (°C) of the reactor 42 itself. In addition, in Table 4, "inside temperature calculation" of the eighth column shows an output/input ratio calculated on the basis of the heating value calculated from the temperature in the reactor 42, and "reactor temperature calculation" of the ninth column shows an output/input ratio calculated on the basis of the heating value calculated from the temperature of the reactor 42 itself.

[0128]

Also from Table 4, it could be confirmed that the excess heat was generated when the inside of the reactor 42 was controlled to the protium gas atmosphere, and the wound type reactants 50 and 51 and the reactant 26 in the reactor 42 were heated by a heater in this state, because at least one of output/input ratios of "inside temperature calculation" of the eighth column and "reactor temperature calculation" of the ninth column becomes 1 or higher.

[0129]

...(omitted)..."

E Other embodiments

(A) "[0086]

(4) Other embodiments

The present invention is not limited to the above described embodiments, and can be suitably changed within a range of the scope of the present invention. For instance, in the above described embodiments, the metal nanoparticle has been described which has the curved surface and shows such a shape that a part of a spherical particle, an elliptical particle, or an egg-shaped particle is embedded in the surface as a metal nano protrusion. However, the present invention is not limited to the above shapes, and a strip-shaped metal nano-protrusion 83 having a nano-sized width may be applied, as shown in Fig. 13A, or a plate-shaped reactant 80 may also be applied, as shown in Fig. 13A.

...(omitted)...

[0090]

Thus, the metal nano-protrusions are formed desirably so as to have a width of 1000 [nm] or smaller, preferably 300 [nm] or smaller, more preferably 10 [nm] or smaller, and further preferably 5 [nm] or smaller, and the shape may be a strip shape, a rectangular shape, or any of various other shapes.

(B) "[0130]

(4-3) Reactants according to other embodiments

In the heat-generating device 1 shown in Fig. 1, the heat-generating device 41 shown in Fig. 5, and the heat-generating device 65 shown in Fig. 12, a plurality of metal nanoparticles having the nano-size are formed as metal nano-protrusions on the surfaces of the reactants 26, 80, and 81 which have reticulated shapes formed by the thin wires. However, it is also acceptable, for instance, to deposit a hydrogen storage metal of Ni, Pd, Pt, or Ti having a fine particle shape (hereafter referred to as fine particle body of hydrogen storage metal) which is smaller than the metal nanoparticle (metal protrusion), on the surfaces of metal nanoparticles on the surfaces of the reactants 26, 80, and 81, and form the surface of the metal nanoparticle to be in an uneven state by the fine particle bodies of the hydrogen storage metal.

...(omitted)...

[0133]

In addition, the heat-generating device 41 shown in the Fig. 5 shall have a structure in which, for instance, the reactant 26 is formed from Ni, Pd, Pt, or the like, and the thin wires 53 and 61 of the wound type reactants 50 and 51 are formed from Ni, Pd, Pt, or the like. In the heat-generating device 41 shown in Fig. 5, when the plasma is generated in the reactor 42, a part of the wound type reactants 50 and 51 which becomes the electrode pair is chipped and scattered in the reactor 42 as the fine particle bodies of the hydrogen storage metal, and the microscopically fine particle bodies of the hydrogen storage metal formed from Pd can be deposited on the surface of the metal nanoparticle of the surface of the reactant 26. Thereby, the heat-generating device 41 becomes a structure in which on the surfaces of the metal nanoparticles formed from Ni or the like, a plurality of the fine particle bodies of the hydrogen storage metal formed from the same Ni or different type of Pd or the like are deposited; the surface of the reactant 26 further remarkably progresses to a more finely uneven state; the probability of causing the tunnel nuclear fusion reaction can be further remarkably raised in the subsequent exothermic reaction process; and thus heat can be generated more stably than conventionally possible.

...(omitted)...

[0136]

The metal nanoparticle having the fine particle bodies of the hydrogen storage metal formed on the surface, which are finer than the metal nanoparticle, may be previously formed on the surfaces of the reactants 26, 80, and 81, the wound type reactants 25, 50, 51, and 66, and the inside reactant 72, with the use of a CVD (chemical vapor deposition) method or a sputtering method before the reactants 26, 80, and 81, the wound type reactants 25, 50, 51, and 66, and the inside reactant 72 are installed in the reactor."

2 Sorting out of the described matters of the detailed description of the Invention

(1) Problem and the like to be solved by the Invention

According to the descriptions of 1 (1) to (3) above, the detailed description of the Invention describes that regarding a cold nuclear fusion reaction which causes a nuclear fusion reaction at room temperature, for the purpose of solving a problem that the exothermic phenomenon cannot occur stably, the heat-generating device of the Invention is adopted; and an effect of generating heat more stably than conventionally possible is obtained.

(2) Heat-generating device of first embodiment

According to 1 (4) A above, the detailed description of the Invention describes the following matters, regarding the heat-generating device of the first embodiment.

Also, as described in A mentioned below, although the heat-generating device of the first embodiment is not equipped with one wound type reactant and the other wound type reactant, and thus does not correspond to the heat-generating device of the Invention, as described in (3) mentioned below, a part of that is referred to in the second embodiment.

A The heat-generating device of the first embodiment is described as follows.

"A heat-generating device comprising:

a reactor 2;

a wound type reactant 25 and a reactant 26 provided_in a reactor 2 as an electrode pair;

a gas supply unit 3 which supplies deuterium gas (purity of 99.99%) as a reactant gas;

an evacuation unit 10 which evacuates gas in the reactor 2 through an evacuation pipe 13; and

a tubular heat transporting pipe 32 which is spirally wound along an outer wall of the reactor 2, wherein

the wound type reactant 25 has a structure in which a thin wire 36 which is formed from a hydrogen storage metal, for instance, including any of Pt, Ni, Pd, Ti, and an alloy containing at least one element among the elements, is spirally wound around a perimeter of a shaft part 35 which is a supporting part and is similarly formed from the hydrogen storage metal including Pt, Ni, Pd, Ti, or the alloy containing at least one element among the elements;

the reactant 26 has a reticulated shape formed of a thin wire on the surface, is formed from a hydrogen storage metal which includes, for instance, any of Ni, Pd, Pt, Ti, and an alloy containing at least any one element of these elements so as to be a cylindrical shape, and is installed so that the outer surface covers an inner wall of the cylindrical portion 2a of the reactor 2;

a plasma is generated in the reactor by a glow discharge in a deuterium gas atmosphere by the wound type reactant 25 and the reactant 26 to form fine metal nanoparticles on surfaces of the wound type reactant 25 and the reactant 26;

then, while the gas supply unit 3 supplies a deuterium gas into the reactor 2, the electrode pair causes the glow discharge to generate the plasma in the reactor 2; and

thus hydrogen atoms are occluded in the metal nanoparticles, the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons in the metal nanoparticles and act as heavy electrons, and as a result, an internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk,

and a nuclear fusion reaction which generates heat while emitting neutrons in the reactor 2 is caused."

B Specifically, it is described that heat generation is carried out as following procedures.

(A) Plasma treatment

a The reactant and the wound type reactant which do not have the metal nanoparticles formed on the surface are provided in the reactor 2, and a gas is evacuated in the reactor 2 which is an enclosed space. (a pressure in the reactor is set at 10 to 500 [Pa] (for instance, approximately 100 [Pa]).

b In this state, the wound type reactant 25 is set as an anode, the reactant 26 is set as a cathode, and a voltage of 600 to 1000 [V] (for instance, approximately 1000 [V]) is applied to the electrode pair, thereby causing the glow discharge and generating the plasma in the reactor 2. (It is continued for 600 seconds to 100 hours (preferably 10 hours or more).)

Therefore, a plurality of metal nanoparticles having the nano-size are formed on the surface of the reactant 25 or the wound type reactant 25, and the surface oxide layer thereof is removed to convert the metal nanoparticle on the surface into an activated state.

Also, the surface of the reactant 26 has been previously subjected to acid pickling treatment of immersing a metal in aqua regia or mixed acid at room temperature for several minutes, before the metal nanoparticles are formed thereon, whereby remarkably finer metal nanoparticles can be formed on the surface at the time of the plasma treatment.

(B) Heating treatment

After (A) above, if necessary, heating treatment is performed on the wound type reactant 25 and the reactant 26. For instance, the wound type reactant 25 and the reactant 26 are directly heated by a heater. (It is performed at 100 to 200 [°C] for 3 hours or longer, for instance.)

Thus, protium, H_2O, and a hydrocarbon gas are emitted to facilitate hydrogen atoms to be occluded.

(C) Exothermic reaction process

a After (A) or (B) above, the deuterium gas can be supplied into the reactor 2 by the gas supply unit 3, while the inside of reactor 2 is kept in the vacuum state.

b A voltage of 400 to 1500 [V], preferably 600 to 1000 [V], more preferably 700 to 800 [V], is applied to the wound type reactant 25 and the reactant 26 to cause the glow discharge in the electrode pair, and generate the plasma in the reactor 2.

Thereby, while the heat-generating device 1 generates the plasma in the reactor 2, hydrogen atoms are occluded in the metal nanoparticles on the surfaces of the wound type reactant 25 and the reactant 26, and the nuclear fusion reaction can occur. At that time, hydrogen atoms are occluded in newly formed metal nanoparticles, and the nuclear fusion reaction can occur.

C Regarding the heat-generating device of the first embodiment, it is described that the verification test is performed according to procedures shown in (A) below, and results are shown in (B) below.

(A) Procedures of verification test

a A reactant formed from Ni (purity of 99.9%) which did not have a plurality of metal nanoparticles having the nano-size formed thereon was prepared, and the reactant was installed in the reactor 2. Subsequently, in order that the plasma treatment was performed, the inside of the reactor 2 was evacuated by the evacuation unit 10, and a pressure in the reactor 2 was controlled to approximately 10^{-6} atmospheres.

b A voltage of 1 [kV] was applied to the wound type reactant 25 and the reactant 26 in this state to generate the glow discharge, and the glow discharge was continued to be generated in the reactor 2 for 30 hours. After that, the reactant 26 was taken out from the reactor 2. The surface state of the reactant 26 was checked with an SEM photograph and the like.

c Without taking out the reactant 26 from the reactor 2, 1 [kV] was applied to the electrode pair to continuously generate the glow discharge. Then, the pressure in the reactor 2 was set at approximately 10^{-6} atmospheres, and the deuterium gas was supplied to the reactor 2 at a gas pressure of 10^{-2} atmospheres, by the gas supply unit 3.

d The glow discharge was once stopped, and after the deuterium gas was supplied into the reactor 2, the electrode pair was fully cooled. Then, the voltage of 1 [kV] was applied to the electrode pair again, and the glow discharge was generated.

(B) Results of verification test

a After the procedure of (A) b above, when the surface state of the reactant 26 was checked with an SEM photograph and the like, it was confirmed that a plurality of metal nanoparticles having the nano-size with a particle diameter of 1000 [nm] or smaller were densely formed and the surface became uneven.

b After the procedure of (A) d above, the neutrons were measured after 1 to 2 minutes, with the neutron measuring unit 19.

c In the procedure of (A) d above, the neutrons were generated suddenly after the voltage was supplied to an electrode pair in order to cause the glow discharge. The neutrons were stably generated by the supply of the voltage, and neutrons of 10^{6} were obtained. The amount of the neutrons generated per unit area of the reactant 26 when the exothermic reaction was continued for 200 seconds was calculated, and the value was 10^{5} neutrons.

d It was confirmed that the temperature of the reactor 2 rose after the neutrons were generated. The electric current which flowed in the electrode pair at this time was 30 [mA]. In other words, an electric power became 30 [W]. The amount of heat generated became 1 [kW], and the heating value with respect to the input reached 33 fold.

Further, there is no description specifically about how to measure the amount of heat generated.

Also, although the relationship with the procedures of the verification test mentioned above is not clear, the following results are also described.

e It was also confirmed that the number of such neutrons to be generated could be controlled by a discharge voltage of the electrode pair, and the number of the neutrons to be generated increased exponentially with the voltage.

(3) Heat-generating device of second embodiment

According to the description of 1 (4) above, the detailed description of the Invention describes the following matters as the heat-generating device of the second embodiment. At that time, for the parts that are the same as in the first embodiment, the description of 1 (4) above was also taken into consideration.

Also, the heat-generating device of the second embodiment is equipped with the one wound type reactant and the other wound type reactant, and thus corresponds to the heat-generating device of the Invention.

A The heat-generating device of the second embodiment is described as follows.
"A heat-generating device comprising:

a reactor 2;

a reactant 26 provided in the reactor 2;

a wound type reactant 50 and a wound type reactant 51 which are disposed in the reactor opposite each other, and cause a glow discharge as an electrode pair to generate a plasma; and

a tubular heat transporting pipe 32 which is spirally wound along an outer wall of the reactor 2, wherein

the wound type reactant 50 has a structure in which a thin wire 53 that is formed from a hydrogen storage metal is wound around a supporting part 52 that is formed of a conducting member;

the wound type reactant 51 has a structure in which a thin wire 61 that is formed from a hydrogen storage metal is spirally wound on a shaft part 60 that is formed from the hydrogen storage metal;

a plurality of metal nanoparticles are formed on the respective surfaces of in the wound type reactant 50 and the wound type reactant 51, by a plasma treatment;

a plasma is generated in the reactor by a glow discharge in a deuterium gas atmosphere by the wound type reactant 50 and the wound type reactant 51 while working as the electrode to form fine metal nanoparticles on surfaces of the wound type reactant 50, the wound type reactant 51, and the reactant 26;

then, a deuterium gas is supplied after being heated by a heater in the reactor 42 kept in a vacuum state; and

thus hydrogen atoms are occluded in the metal nanoparticles, the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons in the metal nanoparticles and act as heavy electrons, and as a result, an internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, and a nuclear fusion reaction which generates heat while emitting neutrons in the reactor 2 is caused."

B Specifically, it is described that heat generation is carried out as following procedures.
(A) Plasma treatment

a Gas in the reactor 42 which has been controlled to an enclosed space is evacuated, and the pressure in the reactor is set to 10 to 500 [Pa].

b A voltage of 600 to 1000 [V] is applied to an electrode pair to cause the glow discharge for 600 seconds to 100 hours, and thereby raise the temperature of the reactant 26 to 500 to 600 [°C].

Thereby, a plurality of metal nanoparticles having the nano-size are formed on a surface.

Further, the details are the same as the procedures of the first embodiment of (2) B (A) above.

(B) Heating treatment

Although there is no particular description about the heating treatment of the second embodiment of (2) B (B) above, in the verification test of Paragraph 0071, this treatment was carried out, and thus, similarly to the first embodiment, it can be understood that this treatment is performed if necessary.

(C) Exothermic reaction process

a After (A) or (B) above, while the wound type reactants 50 and 51 and the reactant 26 are heated by the heater, the deuterium gas is supplied to the inside of the reactor 42 in which the vacuum state is kept.

b The heating temperature at which the wound type reactants 50 and 51 and the reactant 26 are heated by a heater is desirably 200 [°C] or higher, and further preferably is 250 [°C] or higher.

Therefore, hydrogen atoms are occluded in the metal nanoparticles on the surfaces of the wound type reactants 50 and 51 and the reactant 26, and a nuclear fusion reaction occurs.

C Regarding the heat-generating device shown in (A) below of the second embodiment, it is described that the verification test is performed according to procedures shown in (B) below, and results are shown in (C) below.

(A) Heat-generating device

In the verification test, the heat-generating device which is equipped with members as follows is used.

a The reactor 42 having a volume of 15 [l] and a weight of 50 [kg] and formed from stainless steel (SUS306)

b The wound type reactant 50 which has the thin wire 53 that has a diameter of 0.1 [mm] and a length of 1000 [mm] and is formed from Pd (99.9% purity) wound 15 times, around the supporting part 52, which has a width of 30 [mm] and a thickness of 2 [mm] and is formed from Al_2O_3 (alumina ceramics)

c The wound type reactant 51 which has the thin wire 61 that has a diameter of 1 [mm] and a length of 300 [mm] and is formed from Pd (99.9% purity) and spirally wound without any gap, around the shaft part 60, which has a diameter of 3 [mm] and a length of 50 [mm] and is formed from Pd (purity of 99.9%).

d The cylindrical reactant 26 of which surface is formed in a reticulated shape by the thin wire that has a diameter of 0.1 [mm] and is formed from Ni (purity of 99.9%).

(B) Procedures of verification test

a The wound type reactants 50 and 51 and the reactant 26 are cleaned ultrasonically with an alcohol and acetone, and are installed in the reactor 42 while having kept the cleaned state so that contamination with oil did not occur.

b As the plasma treatment, gas in the reactor 42 is gradually evacuated, the inside of the reactor 42 is controlled to a vacuum atmosphere of several Pa, then the wound type reactant 50 is set at the anode, the direct current voltage of 600 [V] is applied, and the electric discharge is generated by approximately 20 [mA], for approximately 600 seconds. Next, the electrode voltage is changed, the wound type reactant 50 is set at the cathode, the direct current voltage of 600 [V] is applied, and the electric discharge is generated by approximately 20 [mA], for approximately 1200 seconds. The surface of the reactant 26 subjected to the plasma treatment is observed with an SEM photograph.

c The inside of the reactor 42 is kept at the vacuum state; the wound type reactants 50 and 51 and the reactant 26 are heated at 100 to 200 [°C] for about 3 hours by the heater, and are activated; protium, H_2O, and hydrocarbon-based gases are emitted from the wound type reactants 50 and 51 and the reactant 26; and impurities are removed therefrom.

d The wound type reactant 50 is heated in stages while the vacuum state in the reactor 42 is kept, and when the room temperature difference reaches 140 [°C], the deuterium gas is introduced at 100 [Pa] from the gas supply pipe 8 into the reactor 42.

e After d, the voltage value to be applied to an electrode pair is raised to 45 [V], and the activation treatment is performed by the plasma for 4000 seconds, in order to activate the surface of the thin wire 53 of the wound type reactant 50. After that, the voltage value applied to the electrode pair is lowered to 32 [V] to stop the plasma.

(C) Results of verification test

a After the procedure of (B) b above, it could be confirmed that a plurality of metal nanoparticles having the nano-size with a width of 1000 [nm] or smaller were formed on the surface, and that the surface became uneven. In addition, it could be confirmed that these metal nanoparticles had curved surfaces such as a hemispherical shape or a half elliptic shape.

b It was confirmed that the metal nanoparticles were formed so as to come in contact with each other on the surface of the thin wire 53 on the wound type reactant 50, although the number was not so many as that of the reactant 26, and that a region in which a plurality of metal nanoparticles were densely packed was also formed.

c In the procedure of (B) d above, the room temperature difference immediately rose up to 220 [°C], although the plasma was not generated by the electrode pair.

d In the procedure of (B) d above, the neutrons in the periphery of the reactor 42 were measured by the neutron measuring unit, and as a result, the neutrons were measured in the neutron measuring unit from the time when the deuterium gas was introduced into the reactor 42 and the wound type reactant 50 began to generate heat.

e In the procedure of (B) e above, when the voltage value to be applied to an electrode pair was raised to 45 [V], and the activation treatment was performed by the plasma for 4000 seconds, the temperature further rose by 30 [°C] and became 250°C. After that, the voltage value applied to the electrode pair was lowered to 32 [V], and the

plasma was stopped, but the state of the risen temperature stably continued until the deuterium gas was discharged from the reactor 42.

f In the procedure of (B) e above, after the reactor came to the state of stably generating heat at 250 [°C], voltage was applied to the electrode pair to cause the glow discharge, and the activation treatment by the plasma was performed, in order to activate the surface of the thin wire 53 of the wound type reactant 50 again. However, further temperature rise could not be confirmed.

(D) Functions and effects of heat-generating device of second embodiment

a When energy is given by heating with the heater, hydrogen atoms are occluded in the metal nanoparticles of the wound type reactant 50, the wound type reactant 51, and the reactant 26; and the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons, and act as heavy electrons. As a result, the internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, the probability of causing the tunnel nuclear fusion reaction can be raised, and thus, the heat equal to or more than a heating temperature can be generated more stably than conventionally possible.

b When the plasma is generated by the electrode pair in the reactor to become a deuterium gas atmosphere, heat generation is promoted and the exothermic temperature further rises; and even if the plasma is stopped, the reactor 42 can continue to keep the state in which the temperature has risen, as long as the inside of the reactor 42 is kept at the deuterium gas atmosphere.

c The wound type reactant 51 is further provided in addition to the reactant 26 and the wound type reactant 50, a plurality of metal nanoparticles are formed also on this wound type reactant 51, accordingly the regions in which the metal nanoparticles are formed increase, correspondingly hydrogen atoms become easily occluded in the metal nanoparticles, and the probability at which the nuclear fusion reaction occurs can be enhanced."

(4) Heat-generating device of third embodiment

The heat-generating device of the third embodiment, according to the descriptions mentioned in 1 (4) C above, is not equipped with the one wound type reactant and the other wound type reactant, and thus does not correspond to the heat-generating device of the Invention. Further, since there is no description especially associated with the Invention, the sorting out of the described matters is omitted.

(5) Verification test by using deuterium gas, and protium gas

According to 1 (4) D above, regarding a verification test for examining output total energy and the like when the deuterium gas and the protium gas are used, the detailed description of the Invention describes that the verification shown in B below was carried out by using the heat-generating device 41 of the second embodiment shown in A, and the verification result shown in C below was obtained.

A Heat-generating device

The heat-generating device 41 of the second embodiment is used in which the reactant 26 was prepared which was a net of 100 mesh formed by a thin wire that had a

diameter of 0.05 [mm] and was formed from Ni (99.9% purity), and had a height of 30 [cm] and a width of 30 [cm].

B Procedures of verification test

(A) As the plasma treatment, the wound type reactant 50 is set at the anode, the direct current voltage of 600 to 800 [V] is applied, and the electric discharge is generated by approximately 20 to 30 [mA] for approximately 10 [ks] seconds. Thus, a plurality of metal nanoparticles having the nano-size are formed on the surfaces of the wound type reactant 50, the wound type reactant 51, and the reactant 26. After such plasma treatment, the deuterium gas is supplied into the reactor 42, and the gas pressure in the reactor 42 is examined.

(B) After (A), the deuterium gas is supplied into the reactor 42, and the exothermic reaction process is performed which caused the nuclear fusion reaction in the reactor 42.

(C) While the inside of the reactor 42 is kept at the vacuum state, and the type of gases supplied into the reactor 42 by a gas supply unit 3, the gas pressure at the time when the gas is supplied, and the input heating wattage of the heater which heats the electrode pair are changed; and various numerical values such as the temperature of the reactor 42 are examined.

(D) The gas components in the reactor 42 after the exothermic reaction process are examined. In the exothermic reaction process, the electrode (wound type reactant 50) is heated for about 84 [ks] with a heater, while the deuterium gas is supplied into the reactor 42 in the evacuated state. At this time, an input into the heater is set at 46 [W] for the first 7 [ks], and is set at 81 [W] after that. In the meantime, the gas was exhausted from the reactor 42 several times.

(E) Then, in order to more correctly identify the gas components, the heat generation test is performed in the heat-generating device 41 for 30 days by using the deuterium gas.

C Verification result

(A) At the time of (B) above, the deuterium gas was supplied into the reactor 42, and the gas pressure in the reactor 42 was examined, and as a result, it was confirmed that the gas pressure decreased to 40 [Pa] from 170 [Pa].

(B) The result when a deuterium gas is used as the gas to be supplied into the reactor 42 is indicated in Table 1 of Paragraph 0105, and "Input Energy kJ" of the eleventh column in Table 1 is compared with "Output Electrode kJ" of the twelfth column in Table 1 that is output total energy (kJ) calculated from the temperature of the electrode (wound type reactant 50) or "Output Reactor kJ" of the thirteenth column in Table 1 that is output total energy (kJ) calculated from the temperature of the outer wall of the reactor 42. As a result, it could be confirmed that that heat could be generated by the heat-generating device 41.

Further, although "Input Electrode kJ," "Output Electrode kJ," and "Output Reactor kJ" above correspond to values obtained by multiplying "Input Watt" of the third column in Table 1 that is the input heating wattage (W) of the heater, "Output/W Electrode" of the fourth column in Table 1 that is a heat output (W) calculated from the temperature of the electrode (wound type reactant 50), and "Output/W Reactor" of the fifth column in Table 1 that is a heat output (W) calculated from the temperature of the

reactor 42 respectively with excess heat duration time "Time ks" of the sixth column in Table 1, there is no particular description about how to calculate them.

(C) The result when the deuterium gas or the protium gas is used as the gas to be supplied into the reactor 42 is indicated in Table 3 of Paragraph 0120, and from "Hout/Hin Estimated by Electrode temp" of the eleventh column in Table 3 that is an output/input ratio calculated on the basis of the temperature of the electrode (wound type reactant 50), and "Hout/Hin Estimated by reactor temp" of the twelfth column in Table 3 that is an output/input ratio calculated on the basis of the temperature of the outer wall of the reactor 42, in Sample No. 33 of Table 3, since the plasma discharge was not performed and the heating for the electrode pair by a heater also was not performed, it could be confirmed that the excess heat did not occur, and it could be confirmed that in other samples, the excess heat occurred, from the output/input ratio of the eleventh column and the twelfth column.

Further, there is no particular description about how to calculate the "Hout/Hin Estimated by Electrode temp" and the "Hout/Hin Estimated by reactor temp." Also, in Sample No. 33 of Table 3, the fields of the "Hout/Hin Estimated by Electrode temp" and the "Hout/Hin Estimated by reactor temp" are blank.

(D) The result when the protium gas is used as the gas to be supplied into the reactor 42 is indicated in Table 4 of Paragraph 0126, and it could be confirmed that the excess heat was generated because at least one of output/input ratios of "inside temperature calculation" of the eighth column and "reactor temperature calculation" of the ninth column in Table 4 becomes 1 or higher.

Further, there is no particular description about how to calculate the "inside temperature calculation" and the "reactor temperature calculation" of the ninth column.

(E) In the procedure B (D) above, in the deuterium gas which is a source gas, D_2^+ with the mass number 4 had a partial pressure of 202 [Pa], HD^+ with the mass number of 3 had 42 [Pa], and H_2^+ with the mass number of 2 had 5 [Pa]. As impurities, those with the mass number estimated to be OD_2^+, OD_2^+, H_2O^+, OD^+, or OH^+, were included. After the end of the test, H_2^+ of which mass number is 2 and OHD^+ of which mass number is 19 increased.

(F) In the procedure of B (E) above, the total of components other than the mass number 2 was almost constant after the first change. The mass number 3(HD^+) increased when the gas pressure and the output total energy increased, but the mass number 4 (D_2^+) decreased when the gas pressure and the output total energy increased, and thus these tendencies mean that the mass number 4 contributes to the generation of the mass number 2 and the mass number 3.

Further, regarding (E) and (F) above, there is no specific description on which method was used for mass spectrometry.

(6) Other embodiments

Regarding other embodiments, a form different from the first to third embodiments mentioned above is described in a method of forming metal nanoparticles.

3 Examination on the description of the detailed description of the Invention

(1) According to the matters sorted out in 2 above, the Invention is intended to solve a problem that concerning a cold nuclear fusion reaction which causes a nuclear fusion reaction at room temperature, the exothermic phenomenon thereof cannot occur stably.

The Invention forms a plurality of metal nanoparticles having a nano-size of 1000 [nm] or smaller on surfaces of one wound type reactant, the other wound type reactant, and a cylindrical reactant by the plasma treatment of 2 (3) B (A) above, and then discharges protium, H_2O, and a hydrocarbon gas from the one wound type reactant, the other wound type reactant, and the cylindrical reactant, by the heating treatment of 2 (3) B (B) above. Finally, according to the Invention, it is assumed that like the exothermic reaction process of 2 (3) B (C), a phenomenon occurs that while the one wound type reactant, the other wound type reactant, and the cylindrical reactant are heated, when the deuterium gas or the protium is supplied into a reactor kept in a vacuum state and hydrogen atoms are occluded in the metal nanoparticles, electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons and act as heavy electrons, as a result, an internuclear distance between the hydrogen atoms in the metal nanoparticles is shrunk, the probability at which a nuclear fusion reaction occurs can be raised, and thus, excess heat can be generated.

(2) Then, in the detailed description of the Invention, in order to verify that the Invention can be carried out, the verification tests of 2 (3) C and 2 (5) are performed, and it is assumed that the following and the like could be confirmed from results thereof.

A A plurality of metal nanoparticles having a nano-size of 1000 [nm] or smaller were formed on surfaces of one wound type reactant, the other wound type reactant, and a cylindrical reactant.

B When a deuterium gas was supplied into a reactant, gas pressure in the reactor decreased.

C A state in which temperature has risen could stably continue until a deuterium gas or a protium gas is discharged from the reactor.

D Generation of the excess heat could be observed, based on output total energy calculated from the temperature of the one wound type reactant, output total energy calculated from the temperature of an outer wall of the reactor, or the like.

E Neutrons were measured in a neutron measuring unit when the deuterium gas or the protium gas was introduced into the reactor.

F According to mass spectrometry, it can be said that the mass number 4 (D_2^+) contributes to the generation of the mass number 2 (H_2^+) and the mass number 3 (HD^+).

(3) Considering the matters that could be confirmed in (2) above, although it can be confirmed that the phenomena (2) A to C occurred from the detailed description of the Invention, there is no specific description in the detailed description of the Invention as to under which environment the whole device is, and how to calculate the total amount of heat before/after a nuclear fusion reaction, and thus it cannot be understood that excess heat is generated.

Also, the phenomenon that "when hydrogen atoms are occluded in the metal nanoparticles of the reactant, the electrons in the metal nanoparticles are strongly influenced by surrounding metal atoms and other electrons and act as heavy electrons, as a result, the internuclear distance between the hydrogen atoms in the metal nanoparticle is shrunk, and the probability of causing the tunnel nuclear fusion reaction can be raised" cannot be said to be a phenomenon based on a technological common sense, and regarding (2) E and F above, there is no specific description in the detailed description of the Invention what kind of measuring/analyzing device or method was

used, so that the results thereof cannot be evaluated. Therefore, it also cannot be confirmed that the nuclear fusion reaction occurs and the excess heat can be generated thereby.

Therefore, the detailed description of the Invention is not one which a person skilled in the art can understand such that the excess heat is generated by the nuclear fusion reaction in the heat-generating device of the Invention.

(4) Here, generally, in order to prove the generation of a nuclear fusion reaction or excess heat, it is necessary to detect the generation of energy larger than the sum of energy input such as nuclear reaction products such as Neutron, Proton, Positron, Anion, Gamma ray, Helium, Calcium, Nickel, Beryllium, and the like or electrical energy and energy such as released chemical energy, it is necessary to confirm that the detection result is not false recognition of noise due to the influence by background, radioactive contamination, environmental intrusion, voltage fluctuation/temperature fluctuation of detector, etc., and control experiments and the like are also necessary for the confirmation.

Against this, since the appellant submitted the certificate of experimental results with the written statement on December 28, 2016, we will examine this.

A Summary of experiments

According to the certificate of experimental results, the experiment was carried out by Professor Iwamura Yasuhiro of Condensed Matter Nuclear Reaction Research Division, Research Center for ELectron PHton Science (ELPH), Tohoku University, in the laboratory thereof, and was performed for a case using deuterium gas and protium by the procedures (A) to (E) below which are generally similar to the verification test described in the detailed description of the Invention.

Procedures

(A) Experiment without activation treatment

As a comparison example, without performing the plasma treatment described in Paragraph 0101 to Paragraph 0104 of the specification of the application, heating by a heater, and the supply of a deuterium gas into a reactor were carried out.

(B) Plasma treatment

The plasma treatment described in Paragraph 0101 to Paragraph 0104 of the specification of the application was carried out, and a predetermined treatment was carried out on an electrode.

(C) Heating treatment

After the plasma treatment, the heating treatment was carried out. Also, the deuterium gas was introduced into the reactor, and it was investigated whether or not the pressure of the deuterium gas decreased in the reactor, thereby confirming whether or not the occlusion of the deuterium gas by Pd occurs.

(D) Exothermic reaction process

Exothermic reaction process was carried out three times. As the first experiment of the exothermic reaction process, heating by a heater and the introduction of a deuterium gas were carried out, and the measurement of temperature was carried out. In the second experiment, after finishing the first experiment, the inside of the reactor was cooled, then the heating by the heater and the supply of the deuterium gas

into the reactor were executed again, and it was investigated whether or not excess heat that is at a heating temperature or more was generated. Also in the third experiment, after finishing the second experiment, the inside of the reactor was cooled, then the heating by the heater and the supply of the deuterium gas into the reactor were executed again, and it was investigated whether or not excess heat that is a heating temperature or more was generated.

(E) Observation with SEM photograph of surface of wound type reactant

After the plasma treatment was carried out, successively a heating test (measuring temperature characteristics after the activation treatment) was carried out. After the heating test, the wound reactor was taken out from the inside of the reactor 42, the surface thereof was observed with an SEM photograph, and thus investigation was carried out on the presence/absence of metal nanoparticles or the size of the metal nanoparticles.

B Experiment results

Then, according to the experiment, the results (A) to (C) below have been confirmed.

(A) In A (C) above, it was confirmed that the pressure of the deuterium gas in the reactor decreased from 170 [Pa] to 66 [Pa].

(B) By comparison of the temperature in the reactor at the time of the experiment without the activation treatment of A (A) and the temperature in the reactor of the first to third experiments in A (D), the generation of excess heat could be confirmed.

(C) According to A (E) above, it could be confirmed that a plurality of metal nanoparticles are provided on the surface of the wound type reactant 50, and the metal nanoparticles have a nano-size of 1000 [nm] or smaller.

C Examination on experiment of certificate of experimental results

With regard to the experiment results mentioned above, the reproducibility of the verification test described in the detailed description of the Invention, or whether or not the matters pointed out in 3 (3) above were solved will be examined.

(A) The experiment results (A) and (C) above indicate the same results as the results of the verification test of 3 (2) A to C above described in the detailed description of the Invention.

(B) The experiment result (B) is different in the point that the result of the verification test of 3 (2) D above is obtained by observing the generation of excess heat on the basis of the output total energy calculated from the temperature of the one wound type reactant or the output total energy calculated from the temperature of the outer wall of the reactor, whereas, in the experiment result (B), the comparison was carried out with the temperature in the reactor at the time of the experiment without the activation treatment of A (A). Thus, it cannot be determined whether or not the results of the verification test can be reproduced. Also, in the experiment of A above, although it can be understood that the reactor of the heat-generating device is covered by a heat insulation material from Page 5 "Heating experiment at Tohoku University: Installation state (5/5)" of Attached document 1 of the certificate of experimental results, in addition to the fact that it is unclear under which environment other parts are, examination is not carried out on the total amount of heat before/after a nuclear fusion reaction, and thus the generation of excess heat cannot be confirmed.

Also, in the experiment of A above, the measurement of neutrons or a mass spectrometry were not carried out, so that regarding the verification results of 3 (2) E and F above, the reproducibility of the results thereof cannot be confirmed.

D Summary

Therefore, considering the experiments and the experiments results in the certificate of experimental results, a person skilled in the art cannot understand that the heat-generating device of the Invention generates excess heat by a nuclear fusion reaction, from the detailed description of the Invention, and thus the detailed description of the Invention is not clear and sufficient to enable a person skilled in the art to carry out the invention.

4 Examination on the appellant's allegation in reasons for requests

Although the appellant alleges in the reasons for the demand of the request for appeal amended by the written amendment (formality) submitted on January 17, 2018, that "considering the fact that the purpose of the Invention, as described in Paragraph [0004] in the specification, is 'actually, as for such a cold nuclear fusion reaction, the mechanism is not elucidated, the reproducibility is also poor, and the exothermic phenomenon cannot occur stably. Because of this, when it is intended to use such a cold nuclear fusion reaction as the heat source of the heat-generating device, there has been a problem that the probability of occurrence of the exothermic phenomenon is very low and the cold nuclear fusion reaction cannot stably generate heat. Then, the present invention is designed with respect to the above described problem, and is directed at providing a reactant, a heat-generating device, and a heat-generating method, which can generate heat more stably than conventionally possible,' by disclosing the structure of 'the heat-generating device,' a method of producing 'the heat-generating device,' a method of using 'the heat-generating device,' and the verification experiment of excess heat, even though a mechanism of cold nuclear fusion is not completely proved, the detailed description of the Invention is considered to be clear and sufficient to enable a person skilled in the art to carry out the Invention," as shown in 3 D above, since a person skilled in the art cannot understand that excess heat is generated by a nuclear fusion reaction in the Invention, from the detailed description of the Invention, it is impossible even for a person skilled in the art to produce the heat-generating device in which excess heat is generated by a nuclear fusion reaction.

Accordingly, the appellant's allegation cannot be adopted.

No. 5 Closing

As described above, the detailed description of the Invention does not satisfy the requirement of Article 36(4)(i) of the Patent Act, and thus the present application should be rejected.

Therefore, the appeal decision shall be made as described in the conclusion.

September 27, 2018

Chief administrative judge: MORI, Ryosuke

Administrative judge: NISHIMURA, Naofumi
Administrative judge: YAMAMURA, Hiroshi