

DESCRIPTION

Name of invention: REACTOR FOR WATER GENERATION

TECHNICAL FIELD

[0001] The present invention relates to a reactor for water generation, mainly utilized in semiconductor manufacturing equipment, for generating water by reacting hydrogen gas with oxygen gas.

BACKGROUND OF INVENTION

[0002] As this type of reactor, a reactor for water generation 1C as shown in Fig. 6 is known. The reactor for water generation 1C includes a reactor main body 6, which is made by welding an inlet-side main body member 3 having an inlet 2 for raw material gas and an outlet-side main body member 5 having an outlet 4 for water gas facing each other, a first reflecting plate 7 arranged inside of the reactor main body 6 to face the outlet 4 and fixed to an inner wall surface of the reactor main body 6 while maintaining a gap G2 in between, a second reflecting plate 8 arranged inside of the reactor main body 6 to face the inlet 2 for raw material gas and fixed to an inner wall surface of the reactor main body 6 while maintaining a gap G1 in between, wherein the inner wall surface of the outlet-side main body member 5 is coated with a platinum catalyst layer 9. The platinum catalyst layer is exaggeratedly indicated by a dashed line for easy understanding.

[0003] According to the reactor for water generation 1C having the above configuration, oxygen gas and hydrogen gas are supplied into the reactor main body 6 through the inlet 2 for raw material gas, and catalytic reacted with the platinum catalyst layer 9 at a catalyst reaction temperature (400 °C. or less), which is lower than the ignition point (500 to 580 °C.) of the hydrogen gas and the oxygen gas, so that high-purity water gas can be generated without combusting, and can be taken out from the outlet for water gas.

[0004] Further, by being provided with a tapered portion 10 at a peripheral edge portion of the first reflecting plate 7 on a side facing the inner wall surface of the reactor main body 6, the reactor for water generation 1C shown in Fig. 6 can

stably generate water without causing unexpected ignition and combustion. That is, since the catalytic reaction reacts strongly in a part where gas entering the gap G2 between the first reflecting plate 7 and the reactor main body 6, the tapered portion 10 can prevent the raw material gas from flowing rapidly into the gap G2, thus to suppress occurrence of strong catalytic reaction, and to prevent rapid increase in local temperature and ignition.

RELATED DOCUMENT

Patent Literature

[0005] Patent Document 1: Japanese Patent Laid-Open Publication No. 2000-169109

SUMMARY OF INVENTION

Problems to be Solved by Invention

[0006] The above-mentioned conventional reactor for water generation can realize a water conversion ratio of 98% while mitigating ignition risk, and achieve a stable and high water conversion ratio. However, there is a demand for further increasing of the water conversion ratio while mitigating ignition risk.

[0007] Accordingly, an object of the present invention is to provide a reactor for water generation capable of achieving a higher water conversion ratio while mitigating ignition risk.

Solution to Problems

[0008] In order to achieve the above object, a reactor for water generation according to one aspect of the present invention includes a reactor main body having an inlet and an outlet for gas; a first reflecting plate fixed inside the reactor main body and disposed to have a gap with an inner wall surface of the reactor main body, the first reflecting plate being disposed to face the outlet and having a tapered portion at a peripheral edge portion facing the inner wall surface of the reactor main body; a first platinum catalyst layer coating the inner wall surface of the reactor

main body; and a second platinum catalyst layer coating an outer surface of the first reflecting plate, the second platinum catalyst layer being applied more inward from the tapered portion and facing the reactor main body.

[0009] The reactor for water generation further includes a ring-shaped spacer interposed between the first reflecting plate and the inner wall surface of the reactor main body for keeping the gap, and one or more fixing screws for fixing the first reflecting plate to the reactor main body through the ring-shaped spacer, wherein the second platinum catalyst layer may coat the outer surface excluding a portion where the ring-shaped spacer is in contact with the first reflecting plate.

[0010] The second platinum catalyst layer may be applied more inward from the ring-shaped spacer.

[0011] The first platinum catalyst layer and the second platinum catalyst layer may coat a barrier coating, the barrier coating being applied on an entire surface of the inner wall of the reactor main body and an entire surface of the first reflecting plate.

[0012] The reactor for water generation further includes a second reflecting plate fixed inside the reactor main body to disposed to have a gap with the inner wall surface of the reactor main body and disposed to face the inlet, the second reflecting plate being disposed to face the inlet and having a tapered portion at a peripheral portion facing the inner wall surface of the reactor main body, wherein the second reflecting plate may be configured with a barrier coating on an entire surface and without a platinum catalyst layer coating.

EFFECT OF INVENTION

[0013] According to the present invention, it is possible to achieve a higher water conversion ratio while mitigating ignition risk by coating the the second platinum catalyst layer on the outer surface of the first reflecting plate, the second platinum catalyst layer being applied more inward from the tapered portion and facing the reactor main body.

BRIEF DESCRIPTION OF DRAWINGS

[0014] Fig. 1 is a cross-sectional view illustrating a first embodiment of the reactor for water generation according to the present invention.

Fig. 2 is a partially enlarged view of Fig. 1.

Fig. 3 is a III-III line cross-sectional view of Fig. 1.

Fig. 4 is a cross-sectional view illustrating an exemplary modification of the configuration shown in Fig. 3.

Fig. 5 is a cross-sectional view illustrating a second embodiment of the reactor for water generation according to the present invention.

Fig. 6 is a cross-sectional view illustrating a conventional reactor for water generation.

DETAILED DESCRIPTION OF EMBODIMENT

[0015] Embodiments of the reactor for water generation according to the present invention will be described below with reference to Figs. 1 to 5. Note that the same or similar components throughout the entire drawings and all embodiments including the conventional arts are denoted by the same reference numerals.

[0016] Referring to Fig. 1, the reactor for water generation 1A according to the first embodiment is provided with: a reactor main body 6 having an inlet 2 for raw material gas (oxygen and hydrogen) and an outlet 4 for water gas and unreacted raw material gas, a first reflecting plate 7 disposed to face the outlet 4 and fixed inside the reactor main body 6 while maintaining a gap G2 with an inner wall surface of the reactor main body 6, the first reflecting plate 7 having a tapered portion 10 at a peripheral portion facing the inner wall surface of the reactor main body 6, a first platinum catalyst layer 9 coating the inner wall surface of the reactor main body 6, and a second platinum catalyst layer 11 coating an outer surface of the first reflecting plate 7, the second platinum catalyst layer 11 being applied more inward from the tapered portion 10 and facing the reactor main body 6.

[0017] Further, the reactor for water generation 1A is provided with a second reflecting plate 8. The second reflecting plate 8 is disposed to face the inlet 2 and fixed inside the reactor main body 6 while maintaining a gap G1 with an inner wall surface of the reactor main body 6, and has a tapered portion 12 at a peripheral portion

facing the inner wall surface of the reactor main body 6. The second reflecting plate 8 has a function of efficiently diffusing the raw material gas flowing from the inlet 2 into the reactor main body 6.

[0018] The reactor main body 6, which is made by joining an inlet-side main body member 3 and an outlet-side main body member 5, has a short cylindrical outer shape. An internal space P is formed by a recess 3a of the inlet-side main body member 3 and a recess 5a of the outlet-side main body member 5. Each peripheral flange portion 3b, 5b of the recess 3a and the recess 5a is joined by butt welding respectively. The inlet 2 for gas is provided on the inlet-side main body member 3. The outlet 4 for water gas is provided on the outlet-side main body member 5.

[0019] The first platinum catalyst layer 9 mainly coats the outlet-side main body member 5. The first platinum catalyst layer 9 may also coats an inner surface of the peripheral flange portion 3b of the inlet-side main body member 3.

[0020] If the platinum catalyst layer coats the second reflecting plate 8, gases catalyze immediately after entering the main in the gap G1. The second reflecting plate 8 tends to get high temperature due to its small heat capacity as compared with the reactor main body, since the heat cannot be dissipated to outside as the reactor main body 6, if the platinum catalyst layer coats the second reflecting plate 8, ignition may occur. Therefore, it is preferable not to coat the platinum catalyst layer on the second reflecting plate 8.

[0021] The second reflecting plate 8 and the first reflecting plate 7 each has a disc shape. The second reflecting plate 8 and the first reflecting plate 7 are mounted substantially parallelly to the inner wall surface of the reactor main body 6 with gaps G1, G2 in between, and the tapered portions 10, 12 are formed so as a distance from the inner wall surface of the reactor main body 6 increase toward the outer peripheral side.

[0022] The reactor main body 6, the first reflecting plate 7, and the second reflecting plate 8 can be formed by stainless steel, but can also be formed of other materials such as nickel alloy, aluminum alloy, iron-chromium-aluminum alloy, etc.

[0023] A barrier coating 13, which is inert to oxygen and hydrogen, coats the entire surface of the inner surface of the reactor main body 6, the surface of the first

reflecting plate 7, and the surface of the second reflecting plate 8. The first platinum catalyst layer 9 and the second platinum catalyst layer 11 coat the barrier coating 13. The barrier coating prevents impurities in the base material such as stainless steel constituting the reactor main body 6 and the like from being released to the outside, and from being diffused into the platinum catalyst layer, thus to prevent the platinum catalyst layer from deterioration.

[0024] A known material can be used as the barrier coating 13, for example, TiN, Al₂O₃, TiCN, TiAlN, Cr₂O₃, SiO₂, CrN, Y₂O₃ or a mixed material of Y₂O₃ with other metallic oxide (for example, Ta₂O₅, SiO₂, TiO₂, ZrO₂, Al₂O₃, HfO₂, La₂O₃, CeO₂, Ce₂O₂, MgO, ThO₂). The barrier coating 13 can be formed by ion plating method, ion sputtering method, PVD method such as vacuum deposition method, chemical vapor deposition method (CVD method), hot-pressing method, thermal spraying method, or the like. The thickness of the barrier coating 13 may be about 0.1μm to 5μm.

[0025] The first platinum catalyst layer 9 and the second platinum catalyst layer 11 can be formed by vacuum evaporation method, ion plating method, sputtering method, chemical vapor deposition method, hot pressing method, or the like. The thickness of the first platinum catalyst layer 9 and the second platinum catalyst layer 11 are preferably set to 0.1μm to 3μm. The platinum catalyst layers are indicated exaggeratedly by dashed lines in Fig.1 for easy understanding.

[0026] The first reflecting plate 7 is fixed to the reactor main body 6 by fixing screws 15 passing through ring-shaped spacers 14. The gap G2 between the first reflecting plate 7 and the inner wall surface of the reactor main body 6 is maintained by the ring-shaped spacers 14 through which the fixing screws 15 pass. Similarly, the second reflecting plate 8 is fixed to the reactor main body 6 by fixing screws 17 passing through ring-shaped spacers 16. The gaps G1, G2 are preferably 0.5 to 1.0mm, and set to be 0.5mm in the illustrated embodiment. The barrier coating is also applied on the respective surface of the ring-shaped spacers 14, 16 and the fixing screws 15, 17.

[0027] The fixing screws 15 are arranged at predetermined angular intervals (e.g., four locations at 90° intervals) along the tapered portion 10, and disposed radially inward of the tapered portion 10 of the first reflecting plate 7.

[0028] According to the reactor for water generation 1A for water generation having the above configuration, the catalyst reaction is increased and a higher water conversion ratio is obtained by coating the second platinum catalyst layer 11 on the first reflecting plate 7.

[0029] Although the tapered portion 10 prevents rapid rise in temperature, so that the raw material gas do not enter the gap G2 rapidly, when the second platinum catalyst layer 11 also coats the tapered portion 10, the catalytic reaction becomes strong combined with the reaction with the first platinum catalyst layer 9, which leads to a rapid increase in temperature and may cause ignition. Therefore, the second platinum catalyst layer 11 coats the surface more inward from the tapered portion 10, excluding the tapered portion 10.

[0030] Further, in the illustrated embodiments, depending on the material of the ring-shaped spacer 14, the variation in the tightening torque of the fixing screw 15, and the like, the second platinum catalyst layer 11 may be damaged at the portion where ring-shaped spacer 14 is in contact with the second platinum catalyst layer 11 when tightening fixing screw 15, which may causes ignition. Therefore, the second platinum catalyst layer 11 is preferably not to coat the portion in contact with ring-shaped spacer 14, it is preferable to be applied, in a circular shape, radially inward from ring-shaped spacer 14. Further, in order to exactly avoid contacting with ring-shaped spacer 14, it is preferable to keep the second platinum catalyst layer 11 apart from ring-shaped spacer 14 (Fig. 2, Fig. 3) by a predetermined distance L, and the distance L can be 4 to 7mm.

[0031] As a modification, as shown in Fig. 4, the second platinum catalyst layer 11 may coat the surface more inward from the tapered portion 10 excluding only the contact area with the ring-shaped spacers 14. Note that the first platinum catalyst layer 9 may also coat excluding only the contact area with the ring-shaped spacers 14.

[0032] On the other hand, unreacted gas is reduced as the gas flowing into the gap G2 approaches the outlet 4. Since the unreacted gas flowing to the middle of

the gap G2 is reduced, even if there are platinum catalytic layers in both the first reflecting plate 7 and the reactor main body 6, the reaction (temperature rise) is not enough to cause ignition. This allows to obtain a higher water conversion ratio while preventing ignition risk.

[0033] Fig. 5 shows a second embodiment of the reactor for water generation according to the present invention. The reactor for water generation 1B of the second embodiment is provided with a slightly thicker first reflecting plate 7, but without the second reflecting plate 8 in the first embodiment, so that it is more compacted. Since other configurations of the second embodiment are the same as the first embodiment, a detailed description thereof will be omitted.

[0034] The present invention is not construed as being limited to the above-mentioned embodiments, and various modifications are possible within a range that does not depart from the spirit of the present invention.

REFERENCE SIGNS LIST

[0035] 1A,1B,1C Reactor for water generation

2 Inlet

3 Inlet-side main body member

4 Outlet

5 Outlet-side main body member

6 Reactor main body

7 First reflecting plate

8 Second reflecting plate

9 First platinum catalyst layer

10 Tapered portion

11 Second platinum catalyst layer

14,16 Ring-shaped spacer

15,17 Fixing screw

What is claimed is:

1. A reactor for water generation comprising:

a reactor main body having an inlet and an outlet for gas;

a first reflecting plate fixed inside the reactor main body and disposed to have a gap with an inner wall surface of the reactor main body, the first reflecting plate being disposed to face the outlet and having a tapered portion at a peripheral edge portion facing the inner wall surface of the reactor main body;

a first platinum catalyst layer coating the inner wall surface of the reactor main body; and

a second platinum catalyst layer coating an outer surface of the first reflecting plate, the second platinum catalyst layer being applied more inward from the tapered portion and facing the reactor main body.

2. The reactor for water generation according to claim 1, further comprising:

a ring-shaped spacer interposed between the first reflecting plate and the inner wall surface of the reactor main body for keeping the gap; and

one or more fixing screws for fixing the first reflecting plate to the reactor main body through the ring-shaped spacer; wherein

the second platinum catalyst layer coats the outer surface excluding a portion where the ring-shaped spacer is in contact with the first reflecting plate.

3. The reactor for water generation according to claim 2, wherein the second platinum catalyst layer being applied more inward from the ring-shaped spacer.

4. The reactor for water generation according to claim 1, wherein the first platinum catalyst layer and the second platinum catalyst layer coat a barrier coating, the barrier coating being applied on an entire surface of the inner wall of the reactor main body and an entire surface of the first reflecting plate .

5. The reactor for water generation according to claim 1, further comprising:

a second reflecting plate fixed inside the reactor main body and disposed to have a gap with the inner wall surface of the reactor main body, the second reflecting plate being disposed to face the inlet and having a tapered portion at a peripheral portion facing the inner wall surface of the reactor main body, wherein the second

reflecting plate is coated with a barrier coating on an entire surface and without a platinum catalyst layer coating.