

GAS MANAGEMENT ASSEMBLY FOR HIGH PRESSURE HEAT-TREATMENT APPARATUS

BACKGROUND

5 Field

The present disclosure relates to a gas management assembly for a high pressure heat-treatment apparatus that performs gas supply and exhaust for the high pressure heat-treatment apparatus.

10

Description of the Related Art

In general, an ion implantation process during semiconductor fabrication may cause damage to an interface of a wafer. Annealing may be a process of healing the damage to the corresponding wafer through heat treatment. In addition to the annealing, the heat treatment may also be performed on the wafer when activating impurities, when performing a chemical vapor deposition (CVD) process to form a thin film, and when performing an ohmic contact alloy process.

20 During the heat treatment, a gas may act on the wafer. The gas may be supplied at a high pressure to a chamber in which the wafer is accommodated. After the heat treatment is finished, the used gas may be exhausted from the chamber. After the gas is exhausted, the heat-treated wafer may be withdrawn from the chamber. A new wafer and the gas may then be provided to the chamber for the next heat treatment.

A highly flammable gas such as hydrogen or deuterium may be used as the gas for the heat treatment. The used gas may remain in the chamber while being exhausted. When the residual gas meets oxygen flowing into the chamber, a possibility of an explosion or the like may not be ruled out.

SUMMARY

An object of the present disclosure is to provide a gas management assembly for a high pressure heat-treatment apparatus, which may structurally prevent a risk that may be caused by a residual gas remaining in a chamber.

According to an embodiment of the present disclosure, a gas management assembly for a high pressure heat-treatment apparatus includes: a housing having an inner space; a gas supply module disposed in the inner space and configured to supply a gas to internal and external chambers of the high pressure heat-treatment apparatus; a gas exhaust module disposed in the inner space and configured to exhaust the gas caused by heat treatment of an object from the internal chamber; a detection module connected to the gas exhaust module in the inner space and configured to detect the residual gas remaining in the internal chamber; and a control module configured to control at least one of the gas supply module and the gas exhaust module based on a detection result of the residual gas by the detection module.

The gas exhaust module may include a gas exhaust line communicating with the internal chamber to guide the gas from the internal chamber to the outside, and the detection module may include a branch line branching from the gas exhaust line, a detection valve disposed in the inner space and installed in the branch line, and a gas detector configured to detect the residual gas from a flow of the gas flowing from the internal chamber as the detection valve is opened.

The gas detector may include at least one of an active gas detector and an inflow gas detector, the active gas detector may be configured to detect an active gas injected

into the internal chamber to act on the object, and the inflow gas detector may be configured to detect an inflow gas flowing into the internal chamber from the outside.

The detection module may further include a pressure
5 regulator disposed before the active gas detector and configured to lower a pressure of the flow of the gas flowing into the active gas detector to a reference pressure or less.

The control module may control the active gas
10 detector to be operated after the heat treatment of the object, and control the inflow gas detector to be operated before the heat treatment of the object.

The control module may be configured to control the gas supply module to supply an inert gas to the internal
15 chamber when operating the gas detector.

The assembly may further include a discharge module configured to discharge the gas from the inner space, wherein the gas detector communicates with the discharge module.

20 The assembly may further include an inflow module configured to allow external air to flow into the inner space, wherein based on an operation of the discharge module, the external air flows into the inner space through the inflow module and is then discharged through the
25 discharge module.

The assembly may further include a detection module configured to detect an environment of the inner space, wherein the control module is configured to stop gas supply performed by the gas supply module when determining
30 that gas leak occurs in the inner space from the detection result by the detection module.

According to another embodiment of the present disclosure, a gas management assembly for a high pressure

heat-treatment apparatus includes: a housing having an inner space; a gas exhaust module disposed in the inner space and configured to exhaust a gas caused by heat treatment of an object from a chamber of the high pressure heat-treatment apparatus; a detection module connected to the gas exhaust module in the inner space and configured to detect the residual gas remaining in the chamber at at least one time point before and after the heat treatment of the object; and a control module configured to operate the gas exhaust module to exhaust the gas from the chamber based on a detection result of the residual gas by the detection module, wherein the residual gas is input to the detection module at a pressure lower than an exhaust pressure of the gas caused by the heat treatment.

The gas exhaust module may have a gas exhaust line communicating with the chamber to guide the gas from the chamber to the outside, and the detection module may include a branch line branching from the gas exhaust line, a detection valve disposed in the inner space and installed in the branch line, and a gas detector configured to detect the residual gas from a flow of the gas flowing from the chamber as the detection valve is opened.

The gas detector may include at least one of an active gas detector and an inflow gas detector, the active gas detector may be configured to detect an active gas injected into the chamber to act on the object, and the inflow gas detector may be configured to detect an inflow gas flowing into the chamber from the outside.

The assembly may further include: a gas supply module disposed in the inner space and configured to supply the gas for the heat treatment of the object to the chamber; and a detection module configured to detect an environment of the inner space, wherein the control module is

configured to stop gas supply performed by the gas supply module when determining that gas leak occurs in the inner space from the detection result by the detection module.

The assembly may further include a discharge module
5 configured to discharge the gas from the inner space under control of the control module, wherein the gas detector communicates with the discharge module.

BRIEF DESCRIPTION OF THE DRAWINGS

10 FIG. 1 is a conceptual diagram showing a gas management assembly 100 for a high pressure heat-treatment apparatus according to an embodiment of the present disclosure.

FIG. 2 is a block diagram for explaining a control
15 configuration of the gas management assembly 100 for a high pressure heat-treatment apparatus of FIG. 1.

FIG. 3 is a flowchart for explaining a control method of the gas management assembly 100 for a high pressure heat-treatment apparatus of FIG. 1.

20 FIG. 4 is a conceptual diagram of a gas management assembly 200 for a high pressure heat-treatment apparatus according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

25 Hereinafter, embodiments of the present disclosure are described in detail with reference to the accompanying drawings. Throughout the present disclosure, components that are the same as or similar to each other are denoted by reference numerals that are the same as or similar to
30 each other, and a description thereof is replaced by the first description, even in a different embodiment.

FIG. 1 is a conceptual diagram showing a gas management assembly 100 for a high pressure heat-treatment

apparatus according to an embodiment of the present disclosure.

Referring to the drawing, the gas management assembly 100 for a high pressure heat-treatment apparatus may be a component for not only supplying/exhausting a gas to/from a high pressure heat-treatment apparatus HA, but also detecting the residual gas remaining in the apparatus HA.

First, the description describes the high pressure heat-treatment apparatus HA as follows. The high pressure heat-treatment apparatus HA may have an internal chamber IC and an external chamber EC.

The internal chamber IC may have an accommodation space accommodating an object to be heat-treated. The internal chamber IC may be made of a non-metallic material, for example, quartz, to reduce a possibility that contaminants (particles) occur in a high-pressure and high-temperature process environment. Although simplified in the drawing, a door (not shown) for opening the accommodation space may be positioned at a lower end of the internal chamber IC. The accommodation space may be opened as the door descends, and the object may be put into the internal chamber IC while being mounted on a holder (not shown). As a heater (not shown) disposed outside the internal chamber IC is operated, the internal chamber IC may be heated up to several hundred degrees Celsius. The object may be, for example, a wafer. In this case, the holder may be a wafer boat which may stack the wafers in a plurality of layers.

The external chamber EC may surround the internal chamber IC. Unlike the internal chamber IC, the external chamber EC is free from a problem of contamination of the object, and may thus be made of a metal material. The external chamber EC may also have a door at a lower portion,

and the door of the internal chamber IC and that of the external chamber EC may be opened while descending together.

Now, the description describes the gas management assembly 100 as follows. The gas management assembly 100 may include a housing 110, a gas supply module 120, a gas exhaust module 130, a detection module 140, and a discharge module 150.

The housing 110 may have an inner space 111. The housing 110 may have a substantially rectangular parallelepiped body. The gas supply module 120 and the gas exhaust module 130 may be installed in the inner space 111. The housing 110 may include a door (not shown) through which an operator may access the inner space 111 to replace/repair the gas supply module 120 described below.

The gas supply module 120 may be configured to supply the gas to the high pressure heat-treatment apparatus HA, specifically to the chambers IC and EC. The gas supply module 120 may communicate with a utility line (gas supply line) of a semiconductor factory. The gas supply module 120 may include a first gas supply line 121 communicating with the internal chamber IC and a second gas supply line 125 communicating with the external chamber EC.

Through the first gas supply line 121, the internal chamber IC may be selectively supplied with the gas for the heat treatment of the object, for example, hydrogen/deuterium, fluorine, ammonia, chlorine, nitrogen, or the like. Here, hydrogen/deuterium or the like is an active gas, and nitrogen is an inert gas. The active gas and the inert gas may act on the object while being mixed with each other in the internal chamber IC. Through the second gas supply line 125, the inert gas such as nitrogen or argon may be supplied to the external chamber EC. The

gas injected into the external chamber EC may be specifically filled in a space between the external chamber EC and the internal chamber IC.

The gas supplied to the internal and external chambers
5 IC and EC may be at pressures higher than that of the atmosphere, and form, for example, high pressures ranging from several to several tens of atmospheres. When a first pressure indicates the pressure of the gas supplied to the internal chamber IC and a second pressure indicates the
10 pressure of the gas supplied to the external chamber EC, the second pressure may be set in relation with the first pressure. For example, the second pressure may be set to be slightly higher than the first pressure. Such a pressure difference may prevent gas leak from the internal chamber
15 IC and damage to the internal chamber IC.

A gas supply valve 123 may be installed in the first gas supply line 121 to establish and maintain a relationship between the first pressure and the second pressure. The gas supply valve 123 may supply the gas
20 while measuring an amount of the gas input to the internal chamber IC. Another gas supply valve 127 may be installed in the second gas supply line 125. Opening and closing of the gas supply valve 127 may be controlled based on the pressure of the gas in the external chamber EC. Although
25 identically shown in the form of simple valves for convenience, and the gas supply valve 123 and the gas supply valve 127 may have specific actions different from each other.

The gas exhaust module 130 may be configured to
30 exhaust the gas caused by the heat treatment of the object from the chambers IC and EC. The gas caused by the heat treatment may have a temperature higher than an ignition point of the active gas based on a progress of a high-

temperature process. The gas exhaust module 130, specifically, a gas exhaust line thereof, may communicate with a utility line (gas exhaust line) of the semiconductor factory.

5 The gas exhaust module 130 may specifically include a first gas exhaust line 131 for exhausting the gas from the internal chamber IC and a second gas exhaust line 135 for exhausting the gas from the external chamber EC. The first gas exhaust line 131 may communicate with the top of
10 the internal chamber IC and may also extend out of the external chamber EC. An exhaust valve 133 may be installed in the first gas exhaust line 131. The second gas exhaust line 135 may communicate with the external chamber EC and may also have an exhaust valve 137. The second gas exhaust
15 line 135 may be incorporated into the first gas exhaust line 131. In this case, the active gas exhausted along the first gas exhaust line 131 may be diluted with the inert gas exhausted along the second gas exhaust line 135.

The detection module 140 may be configured to detect
20 the residual gas remaining in the chambers IC and EC, mainly in the internal chamber IC, even when the gas exhaust module 130 is operated. The detection module 140 may have a branch line 141 branching from the gas exhaust module 130, specifically, the first gas exhaust line 131 in the inner
25 space 111.

Gas detectors 143 and 145 may be installed in the branch line 141. The gas detectors 143 and 145 may receive a flow of the gas flowing from the internal chamber IC and detect the residual gas. In detail, the gas detectors 143
30 and 145 may include the active gas detector 143 and the inflow gas detector 145. The active gas detector 143 may detect the active gas such as hydrogen or deuterium, remaining in the internal chamber IC. The inflow gas

detector 145 may detect an inflow gas flowing from the outside, specifically oxygen, when the door of the internal chamber IC (or the door of the external chamber EC) is opened. The gas detectors 143 and 145 may communicate with
5 a discharge duct 151 described below. The type or number of the gas detectors 143 and 145 is not limited to that exemplified in this embodiment, and more/less number of gas detectors may be employed as needed.

Detection valves 147 and 149 may be installed in the
10 branch line 141 to regulate the flow of the gas flowing from the internal chamber IC to the gas detectors 143 and 145. The detection valves 147 and 149 may respectively correspond to the active gas detector 143 and the inflow gas detector 145. The detection valves 147 and 149 may not
15 be opened during a process of exhausting the gas caused by the heat treatment. Accordingly, a high exhaust pressure of the gas caused by the heat treatment may not act on the gas detectors 143 and 145. Instead, a gas having a much lower pressure than the exhaust pressure of the gas caused
20 by the heat treatment may be input to the gas detectors 143 and 145.

As described above, even when the low-pressure gas is input to the gas detectors 143 and 145, the active gas detector 143 may allow only a gas having a lower-pressure
25 than the corresponding gas. This configuration is possible by a pressure regulator 148 installed before the detection valve 147. The pressure regulator 148 may lower the pressure of the gas passing through the detection valve 147 to a reference pressure or less. The active gas detector
30 143 is a sensitive component for detecting the active gas having a parts per million (PPM) level, and may be required to be additionally protected by the pressure regulator 148. Although described as being installed to correspond to the

active gas detector 143, the pressure regulator 148 may also be installed to correspond to the inflow gas detector 145 based on a design.

5 The gas detectors 143 and 145 may be disposed outside the housing 110. On the other hand, a connection portion of the branch line 141 to the first gas exhaust line 131 and the detection valves 147 and 149 may be disposed in the inner space 111. Such a disposition is arranged to respond to a possibility that the active gas leaks from the connection portion and the detection valves 147 and 149.
10 The high exhaust pressure of the gas caused by the heat treatment may act on the connection portion and the detection valves 147 and 149, and a possibility thus exists that the active gas leaks from the corresponding portions.
15 The gas detectors 143 and 145 may not have to be disposed outside the housing 110, and may be disposed in the inner space 111.

The discharge module 150 is configured to discharge the gas from the inner space 111. The gas in the inner
20 space 111 may include the active gas leaking from the gas supply module 120 or the gas exhaust module 130.

The discharge module 150 may include the discharge duct 151 communicating with the inner space 111. The discharge duct 151 may be connected to the utility line
25 (gas exhaust line) of the semiconductor factory. A gate valve 155 may be installed in the discharge duct 151. When the gas in the inner space 111 is required to be discharged, the gate valve 155 may be opened under control of a control module 170 (see FIG. 2).

30 Unlike the above, the detection module 140 may detect the residual gas in the external chamber EC. In this case, the branch line 141 may be connected to the second gas exhaust line 135. A method of detecting the residual gas

in the external chamber EC may be substantially the same as the method described in this specification focusing on the internal chamber IC.

The description describes a control configuration of the gas management assembly 100 with reference to FIG. 2. FIG. 2 is a block diagram for explaining the control configuration of the gas management assembly 100 for a high pressure heat-treatment apparatus of FIG. 1.

Referring to the drawing (and FIG. 1), the gas management assembly 100 may further include the control module 170 and a storage module 180 in addition to the gas supply module 120, the gas exhaust module 130, and the detection module 140, described above.

The control module 170 may be configured to control the gas supply module 120, the gas exhaust module 130, the detection module 140, the discharge module 150, or the like. In detail, the control module 170 may control the gas supply module 120, the gas exhaust module 130, or the like, based on a detection result of the residual gas by the detection module 140.

The storage module 180 may be configured to store data, programs, or the like that the control module 170 may refer to for the control. The storage module 180 may include at least one type of storage medium among a flash memory, a hard disk, a magnetic disk, and an optical disk.

Through this configuration, the control module 170 may control the gas supply module 120 to supply the inert gas to the internal chamber IC when the detection module 140 is operated. This control is to induce the residual gas remaining in the internal chamber IC to flow to the gas detectors 143 and 145.

The description describes more specific details of the control module 170 that controls detection of the

residual gas and controls the gas supply module 120 based on a detection result with reference to FIG. 3. FIG. 3 is a flowchart for explaining a control method of the gas management assembly 100 for a high pressure heat-treatment apparatus of FIG. 1.

Referring to the drawing (and FIGS. 1 and 2), the control module 170 may identify a heat treatment progress step in progress to respond differently to each step of the heat treatment process in the high pressure heat-treatment apparatus HA (S1).

When it is a step before the heat treatment (S3), the control module 170 may operate the inflow gas detector 145 to detect whether the inflow gas remains in the internal chamber IC (S5). Here, the step before the heat treatment may be, in detail, a time point when a new wafer is loaded into the internal chamber IC and the doors of the chambers IC and EC are closed. This step may be before the gas supply and heating to the chambers IC and EC are performed.

When it is a step of the heat treatment in progress (S7), the control module 170 may determine the heat treatment progress step again (S1) after standing-by for a predetermined time (S9).

When it is a step after the heat treatment (S11), the control module 170 may operate the active gas detector 143 to detect whether the active gas remains in the internal chamber IC (S13). Here, the step after the heat treatment may be, in detail, a time point when the gas in the chambers IC and EC is exhausted after the heat treatment on the loaded wafer is performed. In this case, the doors of the chambers IC and EC are not opened, and the heat-treated wafer may still be positioned in the chambers IC and EC.

When the gas detectors 143 and 145 detect the residual gas before and after the heat treatment, the control module

170 may stop or may not resume an operation of the gas supply module 120 (S15). This configuration may prevent the gas supply module 120 from supplying the active gas and the inert gas to the internal chamber IC (and the external chamber EC) of the high pressure heat-treatment apparatus HA.

The control module 170 may also operate the gas exhaust module 130 to exhaust the gas in the internal chamber IC (and the external chamber EC) (S15). This control is to exhaust the active gas and/or the inflow gas existing in the internal chamber IC, thereby eliminating a risk of the residual gas.

When the gas detectors 143 and 145 detect no residual gas before and after the heat treatment, the control module 170 may end the detection of the residual gas.

The description describes another type of the gas management assembly 100 with reference to FIG. 4.

FIG. 4 is a conceptual diagram of a gas management assembly 200 for a high pressure heat-treatment apparatus according to another embodiment of the present disclosure.

Referring to the drawing, the gas management assembly 200 is substantially the same as the gas management assembly 100 of an embodiment, and different by further including a detection module 260 and an inflow module 280. Hereinafter, the description focuses on a configuration different from that in an embodiment. In addition, the description omits the configuration of the high pressure heat-treatment apparatus HA (see FIG. 1) to make the drawing simple.

The detection module 260 may be configured to detect an environment of an inner space 211, and include a gas sensor 261. The gas detector 261 may be configured to detect the active gas leaking in the inner space 211.

The inflow module 280 may be configured to allow external air to flow into the inner space 211. The inflow module 280 may be a damper that is opened and closed by manual manipulation or the control of the control module 170 (see FIG. 2). In the state where the damper is opened, the external air may flow into the inner space 211 by a negative pressure generated by an operation of a discharge module 250.

The inflow module 280 may be disposed opposite to the discharge module 250 with respect to the housing 210. Referring to the drawing, the discharge module 250 may be disposed above the housing 210, while the inlet module 280 may be disposed below the housing 210. This disposition is to lengthen a flow path of the external air in the housing 210 for the leaking gas to be effectively discharged in all areas of the inner space 211.

Through this configuration, the external air may continuously flow into the inner space 211 by the opening of the inflow module 280 and the operation of the discharge module 250. The external air may cause the gas in the inner space 211 to be discharged through the discharge module 250. For example, the leaking gas may be discharged through the discharge module 250 even when slight gas leak occurs in the connection portion of the branch line 241 and the detection valves 247 and 249. Accordingly, a concentration of the active gas in the inner space 211 may be managed below a set concentration.

During the operation of the discharge module 250, the control module 170 may determine a current concentration of the active gas through the gas detector 261. When the current concentration of the active gas in the inner space 211 exceeds the set concentration, the control module 170 may determine that a significant level of gas leak occurs

and take an additional measure. The control module 170 may stop supplying the gas to the chambers 110 and 120 by closing the gas supply valve 223, for example. Accordingly, the active gas is prevented from entering the inner space 211 either. The gas management assembly 200 may be safely operated by these additional measures even when a significant level of the gas leak occurs in the connection portion and detection valves 247 and 249.

The gas management assembly for a high pressure heat-treatment apparatus as described above is not limited to the configurations and operations of the embodiments described above. The above embodiments may be variously modified by selective combinations of all or some of the respective embodiments.

As set forth above, the gas management assembly for a high pressure heat-treatment apparatus according to the present disclosure may include the gas supply module for supplying the gas to the chamber of the high pressure heat-treatment apparatus and the gas exhaust module for exhausting the gas from the chamber, which are provided in the housing, as well as the detection module connected to the gas exhaust module in the housing and detecting the residual gas remaining in the chamber and the control module for controlling the gas supply module and the gas exhaust module based on the detection result, thereby stopping the heat treatment process to exhaust the residual gas when detecting the residual gas in the chamber. In this way, the gas management assembly may structurally prevent the risk that may be caused by the residual gas remaining in the chamber.

WHAT IS CLAIMED IS:

1. A gas management assembly for a high pressure heat-treatment apparatus, the assembly comprising:

- 5 a housing having an inner space;
a gas supply module disposed in the inner space and configured to supply a gas to internal and external chambers of the high pressure heat-treatment apparatus;
a gas exhaust module disposed in the inner space and
10 configured to exhaust the gas caused by heat treatment of an object from the internal chamber;
a detection module connected to the gas exhaust module in the inner space and configured to detect the residual gas remaining in the internal chamber; and
15 a control module configured to control at least one of the gas supply module and the gas exhaust module based on a detection result of the residual gas by the detection module.

- 20 2. The assembly of claim 1, wherein the gas exhaust module includes a gas exhaust line communicating with the internal chamber to guide the gas from the internal chamber to the outside, and
the detection module includes
25 a branch line branching from the gas exhaust line,
a detection valve disposed in the inner space and installed in the branch line, and
a gas detector configured to detect the residual gas from a flow of the gas flowing from the internal chamber
30 as the detection valve is opened.

3. The assembly of claim 2, wherein the gas detector includes at least one of an active gas detector and an inflow gas detector,

the active gas detector is configured to detect an
5 active gas injected into the internal chamber to act on the object, and

the inflow gas detector is configured to detect an inflow gas flowing into the internal chamber from the outside.

10

4. The assembly of claim 3, wherein the detection module further includes a pressure regulator disposed before the active gas detector and configured to lower a pressure of the flow of the gas flowing into the active
15 gas detector to a reference pressure or less.

5. The assembly of claim 3, wherein the control module controls the active gas detector to be operated after the heat treatment of the object, and

20 controls the inflow gas detector to be operated before the heat treatment of the object.

6. The assembly of claim 2, wherein the control module is configured to control the gas supply module to
25 supply an inert gas to the internal chamber when operating the gas detector.

7. The assembly of claim 2, further comprising a discharge module configured to discharge the gas from the
30 inner space,

wherein the gas detector communicates with the discharge module.

8. The assembly of claim 7, further comprising an inflow module configured to allow external air to flow into the inner space,

wherein based on an operation of the discharge
5 module, the external air flows into the inner space through the inflow module and is then discharged through the discharge module.

9. The assembly of claim 8, further comprising a
10 detection module configured to detect an environment of the inner space,

wherein the control module is configured to stop gas supply performed by the gas supply module when determining that gas leak occurs in the inner space from the detection
15 result by the detection module.

10. A gas management assembly for a high pressure heat-treatment apparatus, the assembly comprising:

a housing having an inner space;

20 a gas exhaust module disposed in the inner space and configured to exhaust a gas caused by heat treatment of an object from a chamber of the high pressure heat-treatment apparatus;

a detection module connected to the gas exhaust
25 module in the inner space and configured to detect the residual gas remaining in the chamber at at least one time point before and after the heat treatment of the object;
and

a control module configured to operate the gas
30 exhaust module to exhaust the gas from the chamber based on a detection result of the residual gas by the detection module,

wherein the residual gas is input to the detection module at a pressure lower than an exhaust pressure of the gas caused by the heat treatment.

5 11. The assembly of claim 10, wherein the gas exhaust module has a gas exhaust line communicating with the chamber to guide the gas from the chamber to the outside, and

the detection module includes

10 a branch line branching from the gas exhaust line, a detection valve disposed in the inner space and installed in the branch line, and

a gas detector configured to detect the residual gas from a flow of the gas flowing from the chamber as the
15 detection valve is opened.

12. The assembly of claim 11, wherein the gas detector includes at least one of an active gas detector and an inflow gas detector,

20 the active gas detector is configured to detect an active gas injected into the chamber to act on the object, and

the inflow gas detector is configured to detect an inflow gas flowing into the chamber from the outside.

25

13. The assembly of claim 10, further comprising:

a gas supply module disposed in the inner space and configured to supply the gas for the heat treatment of the object to the chamber; and

30 a detection module configured to detect an environment of the inner space,

wherein the control module is configured to stop gas supply performed by the gas supply module when determining

that gas leak occurs in the inner space from the detection result by the detection module.

14. The assembly of claim 11, further comprising a
5 discharge module configured to discharge the gas from the inner space under control of the control module,

wherein the gas detector communicates with the discharge module.