DEVICE AND SYSTEM FOR DECOMPOSING AND OXIDIZING GASEOUS POLLUTANT

CROSS-REFERENCE TO RELATED APPLICATION

This application is a national stage application of International Patent Application No. PCT/SG2018/050332, filed on July 5, 2018, which is incorporated by reference herein in its entirety.

The application claims priority to US Provisional Application No. 62/529,795, filed on July 7, 2017, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a device for gaseous pollutants, and more particularly to a device for controlling the decomposition oxidation of a gaseous pollutant in semiconductor or other industrial manufacturing processes.

BACKGROUND OF THE INVENTION

Various chemicals used in the semiconductor manufacturing process, as well as toxic by-products that may be produced, will cause significant harm to human bodies and the environment. Examples of these chemicals include mixed gases containing antimony, arsenic, boron, germanium, nitrogen, phosphorus, silicon, selenium, halogen, halogen silane, or perfluoro compounds (PFCs), or by-products formed by the decomposition of the perfluoro compounds (PFCs).

In the conventional art, the harmful mixed gases or by-products are processed through a device for decomposing and oxidizing a

gaseous pollutant, converted into products with lower environmental harm, and then discharged into the environment.

However, there are imperfections in the conventional device for

the washing portion 20 and the hydraulic cyclone portion 30, respectively.

The reaction portion 10 has a top and a bottom, and sequentially includes a first cavity 11, a first intermediate section 12, a second cavity 13, a second intermediate section 14, and a third cavity 15, from the top to the bottom.

Refer to FIG. 2, the first cavity 11 includes a first inner wall 111 and a first outer wall 112. The first inner wall 111 is annular to define a first chamber 113. The first outer wall 112 surrounds the first inner wall 111 and is arranged concentrically with the first inner wall 111. At least one waste gas inlet passage 114 is provided on the first outer wall 112. The waste gas inlet passage 114 penetrates the first outer wall 112 and the first inner wall 111 and communicates with the first chamber 113 to let waste gas (or exhaust gas) enter the first chamber 113 via the waste gas inlet passage 114. In one embodiment, the waste gas is an effluent stream from one or more process chambers. Non-limiting examples of such process chambers include substrate processing systems used in, for example, semiconductor, flat panel, photovoltaic or other silicon and thin film processing applications.

Refer to FIG. 2 and FIG. 3, in one embodiment, the waste gas inlet passage 114 includes a first member 1141, a second member 1142 and a connecting member 1143. Both ends of the connecting member 1143 are connected to the first member 1141 and the second member 1142, respectively. Taking a ground as a reference, the first member 1141 extends in a horizontal direction with the ground, and

one end not connected to the connecting member 1143 connects with the first chamber 113. The second member 1142 extends in a perpendicular direction with the ground and the second member 1142 is parallel to the direction in which the first cavity 11 is arranged. An

angle between the first member 1141 and the first outer wall 112 is between 75° and 135°. In a preferred embodiment, the angle is ranged from 75° to 90°, and more specifically in 90°. Therefore, compared with a conventional waste gas inlet passage that is only a long pipe vertically inserted into a chamber, the device 1 for decomposing and oxidizing a gaseous pollutant prolongs the moving time of waste gas in the device 1, thereby preventing the waste gas from entering the first chamber 113 too quickly to be combusted. In the present invention, the diameter of the waste gas inlet passage 114 is not particularly limited and could be changed as required.

Compared with the conventional device, the size of the reaction portion 10 and the waste gas inlet passage 114 in the invention is much smaller. In one embodiment, the height from a top of the first chamber 113 to a bottom of the water tank 40 is less than 160 cm, and preferably less than 150 cm. In the invention, it may be changed as required.

Refer to FIG. 3, H1 is defined as a distance between a position of the waste gas inlet passage 114 on the first outer wall 112 and the top of the first outer wall 112, and H2 is defined as a distance between the position of the waste gas inlet passage 114 on the first outer wall 112 and the bottom of the first outer wall 112. In one embodiment, H1 is greater than H2; and in another embodiments, H1 may be equal to or smaller than H2 as required. Accordingly, neither H1 nor H2 is 0, and specifically H2 is between 4 inches and 5 inches. Compared with a technology that waste gas is combusted as soon as it enters a

the particle capture rate is increased by increasing the wet area of the washing portion 20 while reducing the flow rate of the fluid.

FIG. 9 is a schematic view of the water tank 40 according to one embodiment thereof. The water tank 40 includes a front surface 41, a rear surface 42 opposite to the front surface 41, and a top surface 43 connecting the front surface 41 and the rear surface 42. The top surface 43 includes at least three communication ports 431, which respectively communicate with the reaction portion 10, the washing portion 20, and the hydraulic cyclone portion 30 (not shown in FIG. 9). In addition, the front surface 41 and/or the rear surface 42 are provided with at least one opening portion 44. As to the opening portion 44, the water tank 40 is easily cleaned without removing other components such as the reaction portion 10 or the washing portion 20.

Besides, in one embodiment, a water spray unit (not shown in figures) is arranged at a position where the fluid flows out of the third cavity 15 of the reaction portion 10, thereby preventing particles in the fluid from entering the washing portion 20. In another embodiment, a pH sensor (not shown in figures) is arranged on the top surface 43 of the water tank 40 to monitor the pH concentration in the water tank 40, and a real-time alarm is given when the value is abnormal. Or, in other embodiments, a water amount monitor (not shown in figures) is used to monitor the amount of water in the water tank 40 to avoid exceeding a maximum allowable range.

The hydraulic cyclone portion 30 is connected to the water tank

of other manufacturing devices (such as the pump 60) are reduced, so that more tools are allowed to be installed in a limited space, and the interconnection wiring of the pump 60 is reduced, thereby achieving the purpose of reducing installation costs and saving time.

The invention also provides a thermal reactor 90 for removing a pollutant from a waste gas. Please refer to FIG. 12. In one embodiment, the thermal reactor 90 includes a thermal reaction unit 91 and a chilling unit 92. The thermal reaction unit 91 includes a chamber 911, at least one waste gas inlet 912 and a flame region 913. The chamber 911 comprises a side wall 914, and the waste gas inlet 912 penetrates the side wall 914 and communicates with the chamber 911 to introduce a waste gas G_w into the chamber 911 in a non-longitudinal direction. The flame region 913 is formed in the chamber 911 and is located below the waste gas inlet 912, so that after the waste gas G_w is introduced into the chamber 911, it moves downwardly along a vertical distance D_v to enters the flame region 913. In the embodiment, the non-longitudinal direction is a horizontal direction. In other embodiments, the non-longitudinal direction may be other non-vertical and oblique direction that comprises an angle less than 90 degrees with a horizontal plane, as shown in FIG. 13. In this way, when the waste gas G_w is introduced into the chamber 911, it will not immediately contact the flame region 913. Therefore, the thermal reactor 90 has an effect of preventing the waste gas G_w from being deposited on an inner wall of the chamber 911 due to incomplete decomposition. The chilling unit 92 is

chamber 911 to provide a pilot flame 917 for igniting the fuel F. In the embodiment, the fuel inlet 915 and the pilot flame inlet 916 are provided below the waste gas inlet 912, and are separated apart from the waste gas inlet 912 by a delayed combustion distance D_d. The chilling unit 92 is arranged below and connected to the thermal reaction unit 91, and the chilling unit 92 is configured to receive a gas stream G_s from the thermal reaction unit 91. The chilling unit 92 includes a water curtain W flowing through an inner wall 921 of the chilling unit 92. In FIG. 12 and FIG. 13, the waste gas inlet 912 penetrates the side wall 914 and communicates with the chamber 911 to introduce a waste gas G_w into the chamber 911 in a non-longitudinal direction. However, in other embodiments, the waste gas inlet 912 may introduce the waste gas G_w into the chamber 911 in other directions, as long as the fuel inlet 915 and the pilot flame inlet 916 are provided below the waste gas inlet 912 and spaced apart by the delayed combustion distance D_d, for the purpose of delayed ignition.

In another embodiment, please refer to FIG. 14. The thermal reactor 90 includes a thermal reaction unit 91, a chilling unit 92 and an ignition unit 93. The thermal reaction unit 91 includes a chamber 911 and at least one waste gas inlet 912. The waste gas inlet 912 communicates with the chamber 911 to introduce a waste gas G_w into the chamber 911. The ignition unit 93 is connected to the thermal reaction unit 91. The ignition unit 93 includes a flame chamber 931. The flame chamber 931 communicates with the chamber 911. The flame chamber 931 includes a fuel F, a pilot flame 932 for igniting

911. The chilling unit 92 is arranged below and connected to the thermal reaction unit 91, and the chilling unit 92 is configured to receive a gas stream G_s from the thermal reaction unit 91. The chilling unit 92 includes a water curtain W flowing through an inner wall 921 of the chilling unit 92.

In another embodiment, please refer to FIG. 14. The thermal reactor 90 includes a thermal reaction unit 91, a chilling unit 92 and an ignition unit 93. The thermal reaction unit 91 includes a chamber 911 and at least one waste gas inlet 912. The waste gas inlet 912 communicates with the chamber 911 to introduce a waste gas G_w into the chamber 911. The ignition unit 93 is arranged below the thermal reaction unit 91 and connected to the thermal reaction unit 91. The ignition unit 93 includes an outer wall, an inner wall, a premixing chamber defined between the outer wall and the inner wall, and a flame chamber 931 defined by the inner wall. FIG. 4A and FIG. 4B show the structure of the ignition unit 93. The chilling unit 92 is arranged below and connected to the ignition unit 93, and the chilling unit 92 is configured to receive a gas stream G_s from the thermal reaction unit 91. The chilling unit 92 includes a water curtain W flowing through an inner wall 921 of the chilling unit 92.

In another embodiment, please refer to FIG. 16. The thermal reactor 90 includes a first thermal reaction unit 91A, a chilling unit 92, an ignition unit 93, a second thermal reaction unit 94, and an oxygen-rich gas supply unit 95. The first thermal reaction unit 91A includes a chamber 911 and at least one waste gas inlet 912. The

What is Claimed is:

1. A device for decomposing and oxidizing a gaseous pollutant, comprising a reaction portion, a washing portion, a hydraulic cyclone portion, and a water tank connected to the reaction portion, the washing portion and the hydraulic cyclone portion, characterized in that the reaction portion comprises:

a first cavity, comprising a first inner wall which is annular and a first outer wall arranged concentrically with the first inner wall, the first inner wall defining a first chamber, the first outer wall provided with at least one waste gas inlet passage that penetrates the first outer wall and the first inner wall to communicate with the first chamber, the waste gas inlet passage comprising a first member, a second member and a connecting member, wherein both ends of the connecting member are connected to the first member and the second member respectively, the first member extends in a horizontal direction, one end not connected to the connecting member communicates with the first chamber, and the second member extends in a vertical direction; a first intermediate section, comprising a first inner ring wall and a first outer ring wall arranged concentrically with the first inner ring wall, the first inner ring wall defining a first internal space communicating with the first cavity;

a second cavity, comprising a second inner wall which is annular and a second outer wall arranged concentrically with the second inner wall, the second inner wall defining a second chamber communicating with the first intermediate section;

a second intermediate section, comprising a second inner ring wall and a second outer ring wall arranged concentrically with the second inner ring wall, the second inner ring wall defining a second internal space communicating with the second cavity; and

a third cavity, comprising a third inner wall which is annular and a third outer wall arranged concentrically with the third inner wall, the third inner wall defining a third chamber communicating with the second intermediate section, at least one liquid passage arranged on the third outer wall and penetrating the third inner wall to introduce a liquid into the third chamber.

2. The device of claim 1, wherein an angle between the first member and the first outer wall is between 75° and 135°.

3. The device of claim 1, wherein the reaction portion further comprises an upper cover plate arranged on a top of the first cavity.

4. The device of claim 3, wherein the reaction portion further comprises a charge coupled device sensor, wherein the charge coupled device sensor is arranged on the first outer wall, and one end of the charge coupled device sensor passes through the first outer wall and enters the first chamber.

5. The device of claim 3, wherein the reaction portion further comprises a charge coupled device sensor, wherein the charge coupled device sensor is arranged on the upper cover plate, and one end of the charge coupled device sensor passes through the upper cover plate and enters the first chamber.

6. The device of claim 1, wherein the water tank comprises a front

surface, a rear surface opposite to the front surface, and a top surface connected to the front surface and the rear surface separately, the top surface including at least three communication ports respectively communicating with one end of the reaction portion, one end of the washing portion and one end of the hydraulic cyclone portion, and at least one opening portion arranged in the surface selected from the group consisting of the front surface, the rear surface, and a combination thereof.

7. A device for decomposing and oxidizing a gaseous pollutant, comprising a reaction portion, a washing portion, a hydraulic cyclone portion, and a water tank connected to the reaction portion, the washing portion and the hydraulic cyclone portion, characterized in that the reaction portion comprises:

a first cavity, comprising a first inner wall which is annular and a first outer wall arranged concentrically with the first inner wall, the first inner wall defining a first chamber, and the first outer wall provided with at least one waste gas inlet passage that penetrates the first outer wall and the first inner wall to communicate with the first chamber;

a first intermediate section, comprising a first inner ring wall and a first outer ring wall arranged concentrically with the first inner ring wall, wherein the first inner ring wall defines a first internal space communicating with the first cavity, a first intermediate space is defined between the first outer ring wall and the first inner ring wall, and at least one annular passage is provided in the first intermediate

space for cooling water to flow through;

a second cavity, comprising a second inner wall which is annular and a second outer wall arranged concentrically with the second inner wall, the second inner wall defining a second chamber communicating with the first intermediate section;

a second intermediate section, comprising a second inner ring wall and a second outer ring wall arranged concentrically with the second inner ring wall, the second inner ring wall defining a second internal space communicating with the second cavity; and

a third cavity, comprising a third inner wall which is annular and a third outer wall arranged concentrically with the third inner wall, the third inner wall defining a third chamber communicating with the second intermediate section, at least one liquid passage arranged on the third outer wall and penetrating the third inner wall to introduce a liquid into the third chamber.

8. The device of claim 7, wherein a surface of the first outer ring wall further comprises a premixed gas channel and a combustion gas channel, and the premixed gas channel and the combustion gas channel are both arranged on the first outer ring wall and pass through the first outer ring wall respectively to communicate with the first intermediate space.

9. The device of claim 8, wherein the first inner ring wall comprises a plurality of nozzles and at least one inlet for an entry of a pilot flame, some of the plurality of nozzles are connected to the premixed gas channel, and the other plurality of nozzles are

connected to the combustion gas channel, a premixed gas or a combustion gas is introduced into the first internal space from the premixed gas channel or the combustion gas channel via the plurality of nozzles.

10. The device of claim 7, wherein the water tank comprises a front surface, a rear surface opposite to the front surface, and a top surface connected to the front surface and the rear surface separately, the top surface including at least three communication ports respectively communicating with one end of the reaction portion, one end of the washing portion and one end of the hydraulic cyclone portion, and at least one opening portion arranged in the surface selected from the consisting of the front surface, the rear surface, and a combination thereof.

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Abstract

The invention provides a device and system for decomposing and oxidizing of gaseous pollutants. A novel reaction portion reduces particle formation in fluids during treatment, thereby improving the defect of particle accumulation in a reaction portion. Also, the system comprises the device, wherein a modular design enables the system to have the advantage of easy repair and maintenance.

FIG. 1A