APPARATUS FOR TREATING GASEOUS POLLUTANT WITH PLASMA

FIELD OF THE INVENTION

The invention relates to an apparatus for treating gaseous pollutant, and more particularly to an apparatus for treating gaseous pollutant with plasma.

BACKGROUND OF THE INVENTION

Exhaust gas in the semiconductor manufacturing process contains a variety of chemical substances harmful to the human body or the environment, for example, the most concerned perfluorocompounds (PFCs), such as CF_4, C_2F_6, C_3F_8, etc. Typical exhaust management system comprise combustion treatment system, plasma treatment system, thermal treatment system, wet-scrubber and catalyst treatment system, because the temperature at which perfluorocompounds decompose is relatively high, the combustion and plasma treatment system are preferably adopted. Among them, the plasma treatment system is well-developed technology, and the temperature generated by a plasma torch is relatively high, which is more suitable for decomposing perfluorocompounds, so the plasma treatment system has received much attention in recent years.

According to the source of plasma, the torch generated by the exhaust gas treatment apparatus includes direct current plasma torch and microwave plasma torch, which can be found in U.S. Patent Publication No. 20180071751A1, U.S. Patent No. 9937467, U.S. Patent No. 9346005, U.S. Patent No. 9371581, U.S. Patent No.

10064262, U.S. Patent No. 9512518, U.S. Patent No. 9277636, U.S. Patent Publication No. 20100074821A1, U.S. Patent Publication No. 20100290966A1 and U.S. Patent Publication No. 20090301298A1.

However, the major drawback of the existing technology is that it requires a large amount of electricity and fuel consumption. Therefore, it is difficult to reduce the cost of using the plasma torch to treat waste gas to a reasonable range.

SUMMARY OF THE INVENTION

A main object of the invention is to solve the problem that the conventional plasma torch for treating waste gas requires too much electrical power as well as fuel consumption.

In order to achieve the above object, ,the invention provides an apparatus for treating gaseous pollutant with plasma comprising: a microwave source generating a microwave oscillation; a waveguide component coupled to the microwave source to transmit the microwave oscillation; and a resonant cavity coupled to the waveguide component such that the microwave oscillation is substantially transmitted in the resonant cavity along a waveguide direction, the resonant cavity comprising a first chamber in proximity to the waveguide component and a second chamber distant from the waveguide component, the first chamber comprising an inlet end connected to the waveguide component and an outlet end distant from the waveguide component, the second chamber comprising a communicating end communicated with the outlet end and a closed end away from the communicating end, the second chamber be

top wall and a first bottom wall, the second chamber has a second top wall and a second bottom wall, and there is a second difference in height between and the first bottom wall.

In one embodiment, further comprising an ignition source and a dielectric tube, the dielectric tube is inserted in the second chamber and having a first end in proximity to the ignition source and a second end distant from the ignition source, the second chamber having a second top wall and a second bottom wall, the second end of the dielectric tube protrudes from the second chamber and there is a third difference in height between the second end of the dielectric tube and the second bottom wall of the second chamber.

In one embodiment, further comprising an ignition source and a dielectric tube, the dielectric tube is inserted in the second chamber, the ignition source comprising a probe component, the probe component comprising a support member and at least one tip disposed on the support member, and the tip having an outer diameter between 1.6 mm and 2 mm.

In one embodiment, the ignition gas is selected from a group consisting of air, nitrogen, and argon.

The invention further provides an apparatus for treating gaseous pollutant with plasma comprising: a microwave source generating a microwave oscillation; a waveguide component coupled to the microwave source to transmit the microwave oscillation; and a resonant cavity coupled to the waveguide component such that the microwave oscillation is substantially transmitted in the resonant

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In one embodiment, further comprising an ignition source and a dielectric tube, the dielectric tube is inserted in the second chamber, the ignition source comprises a probe component, and the probe component comprises a support member and at least one tip disposed on the support member, and the tip having an outer diameter between 1.6 mm and 2 mm.

The invention further provides an apparatus for treating gaseous pollutant without requiring fuel comprising: a microwave source generating a microwave oscillation; a waveguide component coupled to the microwave source to transmit the microwave oscillation; and a resonant cavity coupled to the waveguide component and extending along a waveguide direction, the resonant cavity comprising a tapered chamber in proximity to the waveguide component and a combustion chamber distant from the waveguide component, the combustion chamber be configured to receive the microwave oscillation passing through the tapered chamber, and the microwave oscillation interacting with a non-fuel ignition gas in the combustion

fuel gas is not required. In addition to reducing costs, it also achieves an object of saving energy. In addition, the ignition source of the invention only needs the probe, and does not need to be equipped with an ignition transformer and a glow discharge electrode as in the conventional technology, and does not need an ignition transformer to supply electric power to the glow discharge electrode.

In one aspect, the apparatus for treating gaseous pollutant with plasma of the invention can be directly used as an exhaust gas treatment apparatus; alternatively, the apparatus for treating gaseous pollutant with plasma of the invention can also be used as a exhaust gas treatment module to be integrated with other forms of exhaust gas treatment apparatuses.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective assembly view of one embodiment of the invention.

FIG. 2 is a partial cross-section perspective view of FIG. 1 along the XZ plane.

FIG. 3A is a cross-section view of FIG. 1 along the XZ plane.

FIG. 3B is a partially enlarged cross-section view of FIG. 3A.

FIG. 4A is a cross-section view of FIG. 1 along the XY plane.

FIG. 4B is a partially enlarged cross-section view of FIG. 4A.

FIG. 5 is a perspective assembly view of a probe component in one embodiment of the invention.

FIG. 6A is a partial perspective assembly view of a first embodiment of the invention.

FIG. 6B is a side view of FIG. 6A.

FIG. 7A is a partial perspective assembly view of a second embodiment of the invention.

FIG. 7B is a side view of FIG. 7A.

FIG. 8A is a partial perspective assembly view of a third embodiment of the invention.

FIG. 8B is a side view of FIG. 8A.

FIG. 9 is a partial schematic diagram of a fourth embodiment of the invention.

FIG. 10 is a perspective assembly view of another embodiment of the invention.

FIG. 11 is a cross-section view of FIG. 10 along the YZ plane.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention discloses an apparatus for treating gaseous pollutant with plasma. Referring to FIG. 1, FIG. 2, FIG. 3A, FIG. 3B, FIG. 4A and FIG. 4B. In one embodiment, the apparatus comprises a microwave source 10, a waveguide component 20, a separator 30, a resonant cavity 40, a dielectric tube 50, a probe component 60, a moving member 70, a cooling assembly 80, and a dielectric window assembly 90. The microwave source 10 is used to generate a microwave oscillation. In this embodiment, the microwave source 10 may be a magnetron. The waveguide component 20 is in proximity to the microwave source 10 and is coupled to the microwave source 10. The waveguide component 20 comprises a cavity 21, which is in

in the second chamber 42 according to the different heights H_b of the second body 42b, the different heights H_c of the third body 42c and the different distances H_d.

Table 3

H_b (mm)	H_c (mm)	H_d (mm)	Maximum field intensity (V/m)
75	75	105	120380
40	40	60	474520
20	20	35	1528900
60	60	115	461070
30	30	45	709300
50	50	125	220540
10	10	55	569970
15	15	70	488460
25	25	160	215230

Table 4

H_b (mm)	H_c (mm)	H_d (mm)	Maximum field intensity (V/m)
40	0	95	871530
35	5	100	1040100
30	10	25	827990
25	15	110	2387600
20	20	35	1528900
15	25	165	222230
10	30	125	426190
5	35	130	790510
0	40	175	3247600

Among the above mentioned configurations, the example in Table 4 has the highest maximum field intensity. The structure of this configuration is shown in FIG. 9.

Referring to FIG. 10 and FIG. 11 of the invention for a perspective assembly view, respectively, and a cross-section view of FIG. 10 along the YZ plane of another embodiment of the invention. In this embodiment, the apparatus for treating gaseous pollutant with

What is Claimed is:

1. An apparatus for treating gaseous pollutant with plasma comprising:

a microwave source configured to generate a microwave oscillation;

a waveguide component coupled to the microwave source and configured to receive the microwave oscillation such that the microwave oscillation is propagated through the waveguide component; and

a resonant cavity coupled to the waveguide component such that the microwave oscillation is substantially propagated in the resonant cavity along a waveguide direction, the resonant cavity comprising a first chamber in proximity to the waveguide component and a second chamber distant from the waveguide component, the first chamber comprising an inlet end connected to the waveguide component and an outlet end opposite to the waveguide component, the second chamber comprising a communicating end communicated with the outlet end and a closed end opposite to the communicating end, the second chamber being configured to receive the microwave oscillation passed through the first chamber, the microwave oscillation interacting with an ignition gas in the second chamber to generate a torch;

wherein, the waveguide direction is substantially parallel to a reference axis defined in the first chamber, the first chamber comprises an inner wall around the reference axis and extending along the reference axis, the inner wall comprises a first region

inclined to the reference axis and a second region substantially parallel in respect to the reference axis, an area of the first region is larger than that of the second region so that the first chamber comprises a tapered shaped space which becomes narrower from the inlet end to the outlet end.

2. The apparatus for treating gaseous pollutant with plasma according to claim 1, wherein the inner wall comprises a first inner side wall and a second inner side wall opposite to the first inner side wall, and the first inner side wall and the second inner side wall respectively obliquely incline inwardly toward the reference axis from the inlet end to the outlet end.

3. The apparatus for treating gaseous pollutant with plasma according to claim 1, wherein the inner wall comprises a first inner side wall and a second inner side wall opposite to the first inner side wall, and a width between the first inner side wall and the second inner side wall is gradually decreasing along the reference axis.

4. The apparatus for treating gaseous pollutant with plasma according to claim 1, wherein the inner wall of the first chamber comprises a first top wall and a first bottom wall, the second chamber comprises a second top wall and a second bottom wall, and a first difference in height is provided between the second top wall and the first top wall.

5. The apparatus for treating gaseous pollutant with plasma according to claim 1, wherein the inner wall of the first chamber comprises a first top wall and a first bottom wall, the second chamber comprises a second top wall and a second bottom wall, and a second difference

in height is provided between the second bottom wall and the first bottom wall.

6. The apparatus for treating gaseous pollutant with plasma according to claim 1, further comprising an ignition source and a dielectric tube, wherein the dielectric tube is inserted in the second chamber and comprises a first end close to the ignition source and a second end distant from the ignition source, the second chamber comprises a second top wall and a second bottom wall, the second end of the dielectric tube protrudes out from the second chamber and a third difference in height is provided between the second end of the dielectric tube and the second bottom wall of the second chamber.

7. The apparatus for treating gaseous pollutant with plasma according to claim 1, further comprising an ignition source and a dielectric tube, wherein the dielectric tube is inserted in the second chamber, the ignition source comprises a probe component, the probe component comprises a support member and at least one tip disposed on the support member, and the tip having an outer diameter between 1.6 mm and 2 mm.

8. The apparatus for treating gaseous pollutant with plasma according to claim 1, wherein the ignition gas is selected from a group consisting of air, nitrogen, and argon.

9. An apparatus for treating gaseous pollutant with plasma comprising:

a microwave source configured to generate a microwave oscillation;

a waveguide component coupled to the microwave source and

configured to receive the microwave oscillation such that the microwave oscillation is propagated through the waveguide component; and

a resonant cavity coupled to the waveguide component such that the microwave oscillation is substantially propagated in the resonant cavity along a waveguide direction, the resonant cavity comprising a first chamber in proximity to the waveguide component and a second chamber distant from the waveguide component, the first chamber comprising an inlet end connected to the waveguide component and an outlet end opposite to the waveguide component, the second chamber comprising a communicating end communicated with the outlet end and a closed end opposite to the communicating end, the second chamber being configured to receive the microwave oscillation passed through the first chamber, the microwave oscillation interacting with an ignition gas in the second chamber to generate a torch;

wherein, the waveguide direction is substantially parallel to a reference axis defined in the first chamber, the first chamber comprises a first inner side wall, a second inner side wall opposite to the first inner side wall, a first top wall, and a first bottom wall, the first inner side wall and the second inner side wall obliquely incline inwardly toward the reference axis from the inlet end to the outlet end.

10. The apparatus for treating gaseous pollutant with plasma according to claim 9, wherein a width between the first inner side wall and the

second inner side wall is gradually decreasing along the reference axis.

11. The apparatus for treating gaseous pollutant with plasma according to claim 9, wherein the second chamber comprises a second top wall and a second bottom wall, and a first difference in height is provided between the second top wall and the first top wall of the first chamber.

12. The apparatus for treating gaseous pollutant with plasma according to claim 9, wherein the second chamber comprises a second top wall and a second bottom wall, and a second difference in height is provided between the second bottom wall and the first bottom wall of the first chamber.

13. The apparatus for treating gaseous pollutant with plasma according to claim 9, further comprising an ignition source and a dielectric tube, wherein the dielectric tube is inserted in the second chamber and comprises a first end in proximity to the ignition source and a second end distant from the ignition source, the second chamber comprises a second top wall and a second bottom wall, the second end of the dielectric tube protrudes out from the second chamber and a third difference in height is provided between the second end of the dielectric tube and the second bottom wall of the second chamber.

14. The apparatus for treating gaseous pollutant with plasma according to claim 9, further comprising an ignition source and a dielectric tube, wherein the dielectric tube is inserted in the second chamber, the ignition source comprises a probe component, the probe component comprises a support member and at least one tip disposed on the

support member, and the tip having an outer diameter between 1.6 mm and 2 mm.

15. An apparatus for treating gaseous pollutant without requiring fuel comprising:

a microwave source configured to generate a microwave oscillation;

a waveguide component coupled to the microwave source and configured to receive the microwave oscillation such that the microwave oscillation is propagated through the waveguide component; and

a resonant cavity coupled to the waveguide component and extending along a waveguide direction, the resonant cavity comprising a tapered chamber in proximity to the waveguide component and a combustion chamber distant from the waveguide component, the combustion chamber being configured to receive the microwave oscillation passed through the tapered chamber, and the microwave oscillation interacting with a non-fuel ignition gas in the combustion chamber to generate a torch.

16. The apparatus for treating gaseous pollutant without requiring fuel according to claim 15, wherein the tapered chamber comprises a first top wall and a first bottom wall, the combustion chamber comprises a second top wall and a second bottom wall, and a first difference in height is provided between the second top wall and a bottom end of the first top wall.

17. The apparatus for treating gaseous pollutant without requiring fuel

according to claim 15, wherein an inner wall of the tapered chamber comprises a first top wall and a first bottom wall, the combustion chamber comprises a second top wall and a second bottom wall, and a second difference in height is provided between the second bottom wall and the first bottom wall.

18. The apparatus for treating gaseous pollutant without requiring fuel according to claim 15, further comprising an ignition source and a dielectric tube, wherein the dielectric tube is inserted in the combustion chamber and comprises a first end in proximity to the ignition source and a second end distant from the ignition source, the combustion chamber comprises a second top wall and a second bottom wall, the second end of the dielectric tube protrudes out from the combustion chamber and a third difference in height is provided between the second end of the dielectric tube and the combustion chamber.