

GAS TRANSMISSION ADAPTING DEVICE OF A REMOTE DOPING GAS SUPPLY SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention is related to a doping gas supply system, and more particularly to a gas transmission adapting device of a remote doping gas supply system.

2. Description of the Prior Arts

10 In the semiconductor foundry, the ion implanter requires different doping gas cylinders to supply the doping gases to the corresponding chambers of the ion implanter. The doping gas cylinders are stored in a metal chamber, namely “gas box” in the implanter. Since the doping gas cylinder has a fixed capacity, there is a need of frequent cylinder change out when cylinders run out of doping gas, and this pays for tool time lost and labor cost.

15 It had been reported that remote doping gas supply system was designed to address the frequent cylinder change out operation. Anyhow, the safety esurance in the operation of remote gas supply system remains a critical factor. For instance, it must be avoided the doping gas being ionized in the high-voltage environment during the transmission pipping, where it connects to
20 the metal chamber which locates in the high voltage potential of the ion implanter. Furthermore, another safety concern comes from the impact of earthquake where no damage to doping gas supply pipes is allowed to result in toxic gas leaking.

25 To overcome the above-mentioned safety concerns, the present invention provides a gas transmission adapting device of remote doping gas supply system to mitigate or to obviate the aforementioned problems.

SUMMARY OF THE INVENTION

The objective of the present invention is to provide a gas transmission adapting device of a remote doping gas supply system.

To achieve the objective as mentioned above, the gas transmission
5 adapting device has:

an electrically-insulated box;

an electrically-insulated hard tube perpendicularly mounted in the electrically-insulated box and having a first end and a second end; and

a first flexible pipe having a third end and a fourth end, wherein the
10 third end is airtightly mounted through the electrically-insulated box and is connected to and communicates with the first end of the electrically-insulated hard tube.

With the foregoing description, the gas transmission adapting device of the present invention has the electrically-insulated box and the
15 electrically-insulated hard tube for transmitting a doping gas mounted in the electrically-insulated box. Therefore, the electrically-insulated hard tube is electrically-insulated from a metal chamber coupled to a high voltage power source with high electrical potential. Furthermore, the first end of the electrically-insulated hard tube is connected to and communicates with the first
20 flexible pipe, so the first flexible pipe absorbs the shocking waves caused by the earthquake to increase the safety of the gas transmission adapting device.

Other objectives, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a gas transmission adapting device in

accordance with the present invention located next to the metal chamber;

FIG. 2A is a perspective view of the gas transmission adapting device in accordance with the present invention;

FIG. 2B is another perspective view of the gas transmission adapting device in accordance with the present invention;

FIG. 3 is a piping schematic view of a first embodiment of a gas transmission adapting device in accordance with the present invention;

FIG. 4 is a piping schematic view of a second embodiment of a gas transmission adapting device in accordance with the present invention;

FIG. 5 is a piping schematic view of a third embodiment of a gas transmission adapting device in accordance with the present invention;

FIG. 6A is a figure of Paschen curve of a doping gas (BF_3) used by the present invention; and

FIG. 6B is a figure of Paschen curve of an inert gas (N_2).

DETAILED DESCRIPTION OF THE EMBODIMENTS

With multiple embodiments and drawings thereof, the features of the present invention are described in detail as follows.

With reference to Fig. 1, a gas transmission adapting device 10 of the present invention is located next to a metal chamber 20 and transmits a doping gas at the remote end to the metal chamber 20 mounted on a floor 30. The metal chamber 20 stores multiple and different doping gas bottles (not shown) for supplying the doping gases to an ion implanter (not shown). The metal chamber 20 is coupled to a high voltage power source with high electrical potential (+) and multiple insulators 21 mounted a bottom of the metal chamber 20 are coupled to the high voltage power source with low electrical potential (-). In the present embodiment, the gas transmission adapting device 10 is mounted

in a space between the metal chamber 20 and the floor 30. With reference to Figs. 1A, 2B and 3, the gas transmission adapting device 10 has an electrically-insulated box 11, an electrically-insulated hard tube 12 and a first flexible pipe 13.

5 With reference Figs. 1, 2A and 2B, the electrically-insulated box 11 is made of an electrically-insulated material, such as Epoxy, ceramic, Teflon, Polystyrene, Polyoxymethylene, Phenolic Plastic (Bakelite), Liquid crystal polymer or the like. The electrically-insulated box 11 may be mounted on the floor 30 next to the metal chamber 20 or mounted outside of the metal chamber
10 20. In the present embodiment, a top recess 111 is formed at a top of the electrically-insulated box 11 and a bottom recess 112 is formed at a bottom of the electrically-insulated box 11. Each outside of the electrically-insulated box 11 has a fin-shaped surface to prevent high-voltage discharge caused by falling dust accumulation. In one embodiment, the electrically-insulated box 11 may
15 be mounted on the bottom of metal chamber 20.

 With reference to Fig. 3, the electrically-insulated hard tube 12 is perpendicularly mounted in the electrically-insulated box 11 and has a first end 121 and a second end 122. A length of the electrically-insulated hard tube 12 is d_1 . In the present embodiment, the electrically-insulated tube 12 may be made
20 of sapphire glass, ceramic or plastic material. The plastic material may be one of the ethylene polymers, phenyl ester polymers and thioether polymers.

 With reference to Fig. 3, a third end of the first flexible pipe 13 is airtightly mounted through the electrically-insulated box 11 and connected to and communicates with the first end 121 of the electrically-insulated hard tube
25 12. A fourth end of the first flexible pipe 13 is connected to and communicates with an external doping gas tube. In the present embodiment, BF_3 is used as the

doping gas, but not limited to. The first flexible pipe 13 is made of metal material, such as stainless steel or the like. In the present embodiment, the first flexible pipe 13 is a 1/8 inch stainless steel pipe. The stainless steel is wound into a spring shape. The spring-shaped stainless steel pipe is a

5 three-dimensional element and provides sufficient flexibility when the spring-shaped stainless steel pipe is deformed by force from any dimensional direction. Therefore, when the earthquake generates violent shaking waves, the spring-like stainless steel pipe provides enough buffering space to absorb the shaking waves. In the present embodiment, the first flexible pipe 13 is

10 airtightly mounted through the bottom of electrically-insulated box 11. The third end of the first flexible pipe 13 communicates with the first end 121 of the electrically-insulated hard tube 12 through a pneumatic valve 131 and a metal pipe 132. An air pipe 133 of the pneumatic valve 131 is also airtightly mounted through the electrically-insulated box 11 and connected to an external

15 high-pressure air source 31. Since the pneumatic valve 131 is a normal-closed pneumatic valve, the pneumatic valve 131 turns on when the high-pressure air source supplies the air to the pneumatic valve 131 through the air pipe 133.

The doping gas adopted by the gas supply system of the present invention may be Arsine, Phosphine, Boron Trifluoride, Carbon Monoxide, Germanium

20 Tetrafluoride, Silicon Tetrafluoride, Fluorine Phosphide, Nitrogen Trifluoride, or Germanium Tetrahydride. Alternatively, the doping gas adopted by the gas supply system may be a mixture of one of the gases and a supplemental gas, such as Fluorine, Carbon Dioxide, Hydrogen, Nitrogen or Argon.

In addition, as shown in Fig. 3, the gas transmission adapting device of

25 the present invention further has a second flexible pipe 14. A fifth end of the second flexible pipe 14 is airtightly mounted through a top of the

electrically-insulated box 11 and connected to and communicates with the second end 122 of the electrically-insulated hard tube 12 through a metal pipe 142. The first and second flexible pipes 13, 14 are made of metal material, the second flexible pipe 14 and the second end 122 of the electrically-insulated hard tube 12 are coupled to the high voltage power source with high electrical potential (+), and in contrast, the first flexible pipe 13 and the first end 121 of the electrically-insulated hard tube 12 are coupled to the high voltage power source with low electrical potential (-). However, the first and second flexible pipes 13, 14 are respectively mounted on the top and bottom of the electrically-insulated box 11, so they are electrically insulated from each other by the electrically-insulated box 11. This ensures that there is no high-voltage discharge issue.

With reference to Fig. 4, the first and second flexible pipes 13, 14 may be airtightly mounted through one sidewall 113 of the electrically-insulated box 11, or are respectively and airtightly mounted through the inner walls of the top and bottom recesses 111, 112, as shown in Figs. 2A and 2B. In the present embodiment, the fifth end of the second flexible pipe 14 communicates with the second end 122 of the electrically-insulated hard tube 12 through another pneumatic valve 141 and another metal pipe 142. An air pipe 143 of the pneumatic valve 141 is also airtightly mounted through the sidewall 131 of the electrically-insulated box 11 and then connected to the external high-pressure air source 31. Since the pneumatic valve 141 is a normal-closed pneumatic valve, the pneumatic valve 141 turns on when the high-pressure air source 31 supplies the air to the pneumatic valve 141 through the air pipe 143. In the present embodiment, the first flexible pipe 13 is close to the second flexible pipe 14 since they are secured on the same sidewall 113 of the

electrically-insulated box 11. To prevent the high-voltage discharge issue, an electrically-insulated material is mounted between the first and second flexible pipes 13, 14. As shown in Fig. 2B, the insulation material is formed in the bottom recess 112. Another insulation material (not shown) may be formed in the top recess 111. In addition, as shown in Fig. 4, an insulation board 41 may be laterally mounted in the electrically-insulated box 11 to electrically insulate the first and second flexible tubes 13, 14.

Furthermore, to prevent that the electrically-insulated hard tube 12 is damaged to leak doping gas in or out the electrically-insulated box 11. The air transmission adapting device of the present invention further has an inert gas pipe 15. One end of the inert gas pipe 15 is airtightly mounted through the electrically-insulated box 11. In particular, as shown in Fig. 3, one end of the inert gas pipe 15 is airtightly mounted through the bottom of the electrically-insulated box 11, or as shown in Fig. 4 is airtightly mounted through the sidewall 113 and approaching to a bottom of the sidewall 113 of the electrically-insulated box 11. The other end of the inert gas pipe 15 is connected to an external inert gas source, such as N₂. The inert gas is supplied to an inside of the electrically-insulated box 11 through the inert gas pipe 15. In addition, as shown in Figs. 3 and 4, an exhaust pipe 16 may be airtightly mounted through the top of the electrically-insulated box 11 or on the sidewall 113 and approaching to a top of the sidewall 113 of the electrically-insulated box 11. The exhaust pipe 16 exhausts the inert gas in the electrically-insulated box 11, so a circulating inert gas flow is formed inside the electrically-insulated box 11 to keep the electrically-insulated box 11 clean. Therefore, the circulating inert gas flow is used as a safety measure against the leakage of doping gas.

In addition, the exhaust pipe 16 is further connected to a toxic gas detector 33. The toxic gas detector 33 detects a concentration of doping gas and outputs a detected value. A controller is electrically connected to the high-pressure air source 31 and the toxic gas detector 33. The controller
5 receives the detected value and determines whether the doping gas leaks in the electrically-insulated box 11 according to the detected value. Therefore, the controller 32 controls to turn on or turn off the high-pressure air source 31. When the detected value exceeds a pre-set value, the controller turns off the high-pressure air source 31 and the high-pressure air source 31 stops
10 transmitting the air to the pneumatic valves 131, 141. At the time, the pneumatic valves 131, 141 turn off and shut off the doping gas transmission. This is the second safety measure against the leakage of doping gas.

With reference to Fig. 5, a vacuum pipe 17 is airtightly mounted through the electrically-insulated box 11 and an air pump 34 is connected to the
15 vacuum pipe 17. When the air pump 34 turns on, an air pressure inside the electrically-insulated box 11 is decreased to a vacuum level to keep the electrically-insulated box 11 clean. This is a third safety measure against the leakage of doping gas. In addition, the toxic gas detector 33 is also connected to the vacuum pipe 17. The toxic gas detector 33 detects a concentration of
20 doping gas and outputs a detected value. A controller 32 is electrically connected to the high-pressure air source 31 and the toxic gas detector 33. The controller 32 receives the detected value from the toxic gas detector 33 and determines whether the doping gas leaks in the electrically-insulated box 11 according to the detected value. Therefore, the controller 32 controls to turn on
25 or turn off the high-pressure air source 31. When the detected value exceeds a pre-set value, the controller 32 turns off the high-pressure air source 31 and the

high-pressure air source 31 stops transmitting the air to the pneumatic valve 131. At the time, the pneumatic valve 131 turns off and shut off the doping gas transmission. This is the third safety measure against the leakage of doping gas.

To prevent that the doping gas in the gas transmission adapting device 10 of the present invention is not ionized by the high electrical potential difference, the design of the gas transmission adapting device 10 has to meet Paschen's law $V = f(pd)$, wherein "V" is the ionization voltage causing the electric arc or discharge between the two electrodes, "p" is the gas pressure and "d" is the gap distance between two electrodes. With further reference to Fig. 6A, different Paschen's curves of the doping gas (BF_3) are shown. If the gas pressure of the doping gas in the gas transmission adapting device is constant, different gap distances between the two electrodes respectively determine different ionization voltages causing the electric arc or discharge between the two electrodes. In the present invention, the two electrodes refer to the two metal pipes 132, 142 respectively connected to the first end 121 and the second end 122 of the electrically-insulated hard tube 12. Therefore, when the gas pressure in the electrically-insulated hard tube 12 is constant, the length d1 of the electrically-insulated hard tube 12 is determined to prevent the doping gas from ionization by the high electrical potential difference. And a product of the length and the gas pressure does not fall into a product range of the gas pressures and gap distances corresponding to ionization voltages. That is, the product of the length d1 of the electrically-insulated hard tube 12 and the gas pressure therein is larger than the maximum electrical potential difference for gas ionization between the first end 121 and the second end 122 of the electrically-insulated hard tube 12. Therefore, doping gas is not ionized by the high electrical potential difference between the first and second ends connected

to the metal pipes 132, 421.

In addition, the gas pressure in the electrically-insulated hard tube 12 may be adjusted to meet the Paschen's law. That is, the product of the length and the gas pressure fall into a product range of the gas pressures and gap distances corresponding to higher ionization voltages. That is, the product of the length d1 of the electrically-insulated hard tube 12 and the gas pressure therein is larger than the maximum electrical potential difference for gas ionization between the first end 121 and the second end 122 of the electrically-insulated hard tube 12.

Since the electrically-insulated box 11 is located below the bottom of the metal chamber 20 coupled to a high voltage terminal of the high voltage power source, a high voltage discharge may be occurred and needs further consideration. Therefore, a product of a length d2 of the electrically-insulated box 11 and an internal pressure in the electrically-insulated box 11 is larger than an electrical potential difference for gas ionization between the first end 121 and the second end 122 of the electrically-insulated hard tube 12. That is, with reference to Fig. 6B, the product of the length d2 of the electrically-insulated box 11 and the internal pressure in the electrically-insulated box 11 does not fall into the product range of the gas pressures and the gap distances corresponding to ionization voltages. The inert gas in the electrically-insulated box 11 is not ionized by the high electrical potential difference accordingly.

Based on the foregoing description, in the gas transmission adapting device of the present invention, an electrically-insulated hard tube for supplying the doping gas is securely mounted in an electrically-insulated box. Therefore, the electrically-insulated hard tube is electrically-insulated from the

metal chamber coupled to a high voltage terminal of the high voltage power source. Furthermore, one end of the electrically-insulated hard tube is connected to a flexible pipe and the flexible pipe is able to absorb the shaking waves from earthquake. Therefore, it prevents the electrically-insulated hard tube from damaging and increase the safety of remotely transmitting the doping gas.

Even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and features of the invention, the disclosure is illustrative only. Changes may be made in the details, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

WHAT IS CLAIMED IS:

1. A gas transmission adapting device for an ion implanter, comprising:
an electrically-insulated box;
an electrically-insulated hard tube perpendicularly mounted in the
5 electrically-insulated box and having a first end and a second end; and
a first flexible pipe having a third end and a fourth end, wherein the
third end is airtightly mounted through the electrically-insulated box and is
connected to and communicates with the first end of the electrically-insulated
hard tube.
- 10 2. The gas transmission adapting device as claimed in claim 1, wherein
a product of a length of the electrically-insulated hard tube and an internal
pressure in the electrically-insulated hard tube is larger than a maximum
electrical potential difference for gas ionization between the first end and the
second end of the electrically-insulated hard tube.
- 15 3. The gas transmission adapting device as claimed in claim 2, wherein
a product of a length of the electrically-insulated box and an internal pressure
of the electrically-insulated box is larger than the maximum electrical potential
difference for gas ionization between the first end and the second end of the
electrically-insulated hard tube.
- 20 4. The gas transmission adapting device as claimed in claim 1, 2 or 3,
further comprising a second flexible pipe having a fifth end and sixth end,
wherein the fifth end is airtightly mounted through the electrically-insulated
box and is connected to and communicates with the second end of the
electrically-insulated tube.
- 25 5. The gas transmission adapting device as claimed in claim 4, wherein
the fourth end of the first flexible pipe is used to connect to an external doping

gas tube.

6. The gas transmission adapting device as claimed in claim 4, wherein the third end of the first flexible tube is connected to the first end of the electrically-insulated hard tube through a first pneumatic valve and a first metal pipe, wherein the first pneumatic valve has a first air tube, and the first air tube is used to connect to a high-pressure air source.

7. The gas transmission adapting device as claimed in claim 6, wherein the fifth end of the first flexible tube is connected to the second end of the electrically-insulated hard tube through a second pneumatic valve and a second metal pipe, wherein the second pneumatic valve has a second air tube, and the second air tube is used to connect to the high-pressure air source.

8. The gas transmission adapting device as claimed in claim 6, further comprising an inert gas pipe airtightly mounted through the electrically-insulated box and is used to connect to an inert gas source.

9. The gas transmission adapting device as claimed in claim 8, further comprising an exhaust pipe airtightly mounted through the electrically-insulated box to exhaust a gas in the electrically-insulated box.

10. The gas transmission adapting device as claimed in claim 7, wherein the exhaust pipe is further connected to a toxic gas detector, wherein the toxic gas detector detects a concentration of doping gas and outputs a detected value.

11. The gas transmission adapting device as claimed in claim 10, further comprising a controller is electrically connected to the high pressure air source and the toxic gas detector, wherein the controller controls the high pressure air source to turn on or turn off according to the detected value.

12. The gas transmission adapting device as claimed in claim 4,

wherein:

the first flexible pipe is airtightly mounted through a bottom of the electrically-insulated box; and

the second flexible pipe is airtightly mounted through a top of the electrically-insulated box.

13. The gas transmission adapting device as claimed in claim 4,

wherein:

the first flexible pipe is airtightly mounted through a sidewall of the electrically-insulated box; and

the second flexible pipe is airtightly mounted through the sidewall of the electrically-insulated box.

14. The gas transmission adapting device as claimed in claim 13,

further comprising an electrical insulation material mounted between the first flexible pipe and the second flexible pipe.

15. The gas transmission adapting device as claimed in claim 4,

wherein:

a top recess is formed on a top of the electrically-insulated box;

a bottom recess is formed on a bottom of the electrically-insulated box;

the first flexible pipe is airtightly mounted through an inner wall of the bottom recess; and

the second flexible pipe is airtightly mounted through an inner wall of the top recess.

16. The gas transmission adapting device as claimed in claim 5,

wherein:

an electrical insulation material is mounted between the first flexible pipe and the second flexible pipe; and

an electrical insulation board is laterally mounted in the electrically-insulated box.

17. The gas transmission adapting device as claimed in claim 1, 2 or 3, wherein the electrically-insulated hard tube is made of sapphire glass, ceramic or plastic material, wherein the plastic material is selected from one of ethylene polymers, phenyl ester polymers and thioether polymers.

18. The gas transmission adapting device as claimed in claim 4, wherein the first flexible pipe and the second flexible pipe are made of stainless steel.

19. The gas transmission adapting device as claimed in claim 1, 2 or 3, wherein each outside of the electrically-insulated box has a fin-shaped surface.

20. The gas transmission adapting device as claimed in claim 6, further comprising:

a vacuum pipe airtightly mounted through the electrically-insulated box; and

an air pump connected to the vacuum pipe to decrease an air pressure inside the electrically-insulated box to a vacuum level.

21. The gas transmission adapting device as claimed in claim 20, further comprising:

a toxic gas detector connected to the vacuum pipe to detect a concentration of doping gas and output a detected value; and

a controller electrically connected to the high-pressure air source and the toxic gas detector, wherein the controller controls the high-pressure air source to turn on or turn off according to the detected value.