GAS SUPPLY SYSTEM FOR AN ION IMPLANTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a gas supply system for an ion implanter. It is especially referred to a gas supply system capable of providing multiple doping gases for an ion implanter remotely.

2. Description of the Prior Arts

The ion implanter of the semiconductor equipment includes multiple chambers. And the doping gas adopted in each of the chambers would be varied by the different recipes of different products and processes. The doping gas tends to be ionized in the high-voltage environment and it is toxic to the human body as well. Therefore, the doping gas would be stored in a vessel in advance and installed in a gas box of the ion implanter. The metal chamber has the tubes for transporting the doping gas into the ion implanter. The metal chamber would be electrically connected to the high voltage power source, in other words, the metal chamber is coupled to a the high voltage power source with a high voltage level, and there would be multiple high voltage insulators disposed between the floor and the bottom of the metal chamber to avoid a high voltage difference induced within the metal chamber.

However, the vessel for storing the doping gas has a limitation in volume, if the doping gas supplied to the chamber during the manufacturing process is not well-controlled, the interruption of ion implantation is resulted and consequently causing product yield loss. Therefore, lots of semiconductor

equipment manufacturers begin to develop the solution about how to connect gas lines in the ion implanter to a remote source of the huge storage tank that contains the doping gas and avoids gas supply interruption. An apparatus of the gas supplying system is shown in Fig.6. There are serials of electrically-insulated tubes 72 and the corrugated metal tubes 73 interconnected with each other between the metal chamber 70 and the remote doping gas storage room 71. The corrugated metal tubes 73 can absorb the energy of vibration from the environment due to its malleability, so the damage of the electrically-insulated tubes 72 could be avoided. In addition, the corrugated metal tubes 73 is made of the metal material and the metal chamber is coupled to the voltage power source with a high voltage level, therefore, to avoid that the doping gas is ionized in the high voltage difference occurred within the tubes, as shown in Fig. 6, the metal chamber would be electrically connected with a voltage divider 74 to make the corrugated metal tubes 73 electrically connected to the node of the voltage divider 74. In this way, the potential of the corrugated tube 73 is lower than the potential of the metal chamber 70, reducing the probability of forming a high voltage differential environment.

It can be seen from the above description that when the ion implanter uses the gas transmission device of the remotely stored dopant gas source, it is necessary to consider the potential safety issues of piping damage by external force vibration and doping gas ionization by the high voltage.

To overcome the shortcomings, the present invention provides a gas supply system capable of providing a doping gas for an ion implanter remotely to mitigate or to obviate the safety risks.

SUMMARY OF THE INVENTION

Considering the safety issue of the aforementioned gas supply system that can provide a doping gas from a remote source, the major objective of the present invention would propose a novel gas supply system for the ion implanter.

The primary technical measures of the gas supply system to fulfill the above objectives have:

a metal chamber electrically-connected to a high voltage power source with a high electrical potential and having:

a first tube; and

a second tube having a first end connected with the first tube and a second end of the second tube extending to an external side of the metal chamber;

multiple electrical insulators mounted at a bottom of the metal chamber and electrically connected to the high voltage power source with a low level;

an electrically-insulated box placed outside the metal chamber;

an electrically-insulated hard tube vertically disposed in the electrically-insulated box and having

a third end connected with the second end of the second tube; and

a fourth end; and

a flexible tube having:

a fifth end extending to an internal side of the electrically-insulated box and connected with the fourth end of the electrically-insulated hard tube;

and

a sixth end connected to a huge storage tank of the doping gas;

wherein:

the electrically-insulated box has a first length and an internal pressure, wherein a product of the first length and the internal pressure is larger than a maximum voltage for gas ionization between a first region where the third end of the electrically-insulated hard tube and the second tube of the metal chamber are connected and a second region where the fourth end of the electrically-insulated hard tube and the flexible tube are connected; and

the electrically-insulated hard tube has a second length and a pressure of doping gas transmitted, wherein a product of the second length and the pressure of the doping gas transmitted is larger than the maximum voltage for gas ionization between the first region and the second region.

From the aforementioned description, it is understood that the gas supply system of the present invention primarily has the electrically-insulated box, the electrically-insulated box creates a high voltage barrier without causing the discharge of the high voltage. In addition, the product of the length of the electrically-insulated hard tube and the high pressure within the electrically-insulated hard tube is larger than the maximum voltage for gas ionization would allow that the metal chamber is operating at a high voltage potential. Furthermore, both of the electrically-insulated box hung on the metal chamber and the electrically-insulated hard tube connected with the

flexible tube are able to absorb the energy of vibration from the environment to avoid the vibration damage to the electrically-insulated hard tube.

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 structure of the first embodiment of the gas supply system in accordance with the present invention;

Fig. 2 is a schematic structure of the second embodiment of the gas supply system in accordance with the present invention;

Fig. 3 is a schematic structure of the third embodiment of the gas supply system in accordance with the present invention;

Fig. 4 is a Paschen curve for a doping gas (shown in this cure, BF_3) adopted by the gas supply system in accordance with the present invention;

Fig. 5 is a Paschen curve for an inert gas (shown in this cure, N_2) adopted by the gas supply system in accordance with the present invention; and

Fig. 6 is a schematic structure representation of one kind of conventional apparatus of the gas supply system in accordance with the prior art.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention relates to a novel gas supply system for an ion implanter. Multiple embodiments are illustrated with the figures below to describe the gas supply system of the invention in detail.

At first, please refer to the first embodiment shown in the Fig. 1, the gas supply system of the present invention comprises a metal chamber 10, multiple electrical insulators 20, an electrically-insulated box 30, an electrically-insulated hard tube 40 and a flexible tube 50.

The metal chamber 10 has a first tube 11 and a second tube 12. The first tube 11 extends to an external side 101 of the metal chamber 10 for transmitting a doping gas to the ion implanter (not shown in the figures). The second tube 12 has one end connected with the first tube 11 and the other end of the second tube 12 extends to the external side 101 of the metal chamber 10. In the first embodiment, the second tube 12 further interconnects with a control valve of pressure monitor 13 to adjust a pressure imported. For instance, when the pressure imported of the second tube 12 is monitored as 35 psi, the control valve of pressure monitor 13 would decrease the pressure of the doping gas in the second tube 12. After the pressure in the second tube 12 becomes smaller than the atmosphere (<14.7psi), the doping gas would be transmitted to the first tube 11. The control valve of pressure monitor 13 would real-time monitor the pressure in the second tube12 to generate and deliver a monitored value of the pressure Sp to a remote controller.

The electrical insulator 20 is mounted between a bottom 102 of the metal chamber 10 and a floor 1, so a distance d1 is defined between the bottom 102 of the metal chamber 10 and the floor 1. In the embodiment, each of the electrical insulators 20 can be a high electrical insulator. The metal chamber 10 and those high electrical insulators are electrically connected to a high voltage

power source (such as 80 kilovoltage; 80KV) with a high electrical potential and the high voltage power source with a low electrical potential, respectively.

The electrically-insulated box 30 is placed outside the metal chamber 10. In the embodiment, the electrically-insulated box 30 may be hung at the external side 101 of the metal chamber 10, the second tube 12 extends to the internal side of the electrically-insulated box 30. In the embodiment, the electrically-insulated box 30 has a length d3 and a first surface 31. The first surface 31 is located at the nearest position to the floor 1 without being attached to it.

The above electrically-insulated hard tube 40 is vertically disposed in the electrically insulated box 30, the electrically-insulated hard tube 40 is substantially parallel to the external side 101 of the metal chamber 10. The electrically-insulated hard tube 40 has a length d2, a first end 41 and a second end 42 connected to the second tube 12. In the embodiment, the material of the electrically-insulated hard tube 40 could either be high rigidity insulators such as the sapphire glass and the ceramics or the plastic material (for example, Ethylene polymer, Phthalates polymer and Sulfide polymer).

As shown in the figure, the flexible tube 50 has one end extending into a first surface 31 of the electrically-insulated box 30 and connected to the second end 42 of the electrically-insulated hard tube 40. The other end of the flexible tube 50 is connected to one remote source of the huge storage tank of the doping gas 71. In the embodiment, the flexible tube 50 may be made of metal material, such as stainless steel or may be another kind of flexible metal

tube. The flexible tube 50 could be disposed beneath the floor 1 without interference with those electrical insulators 20 or other equipment located on the floor 1. The doping gas adopted by the gas supply system of the present invention may be Arsine, Phosphine, Boron Trifluoride, Carbon Monoxide, Germanium 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.

Furthermore, in order to prevent the leakage of the doping gas resulted from the fracture of the electrically-insulated hard tube 40 to the electrically -insulated box 30 and spread to the facilities, the gas supply system of the present invention further has a vacuum pump 61 and a third tube 60 connected with each other. The third tube 60 is electrically connected to the electrically-insulated box 30. The vacuum pump 61 would vacuum an internal pressure of the electrically-insulated box 30 throughout the third tube 60 to create an environment with sub-atmospheric pressure and to purge the leaking doping gas by means of the third tube 60 immediately. With reference to Fig. 2, the second embodiment of the gas supply system of the present invention provides another measure that could solve the leakage of the doping gas resulted from the fracture of the electrically-insulated hard tube 40 to the electrically- insulated box 30 and spread to the facilities. As shown in the figure, the electrically-insulated box 30 is connected to a fourth tube 62. The

fourth tube 62is connected to a high-pressure inert gas source 64 through a valve 63. Once the valve 63 is switched on, the high-pressure inert gas would continuously import into the electrically-insulated box 30, and a pressure of the inert gas is larger than the pressure of the doping gas in the electrically-insulated hard tube 40 all the time. Under the circumstances, when the fracture occurred in the electrically-insulated hard tube 40, because the pressure of the doping gas in the electrically-insulated hard tube 40 is smaller than the pressure of the inert gas in the electrically-insulated box 30, the inert gas is capable of diffusing into the electrically-insulated hard tube 40 and further preventing any possible leakage of the doping gas to the electrically-insulated box 30 and the spread to the facilities completely. The inert gas could be the N_2 gas, other similar inert gas, or the combination thereof.

In addition, the present invention would further have a storage vessel 15 of doping gas disposed in the aforementioned metal chamber 10. The storage vessel 15 is connected to the first tube 11 through a valve 14. The valve 14 could be switched on by demand so that the doping gas stored in the vessel would be provided to the ion implanter throughout the first tube 11. Certainly, the valve 14 could be switched off, the doping gas would be imported sequentially from the second tube 12, the first tube 11 then transmitted to the ion implanter.

With reference to Fig. 3, the third embodiment of the gas supply system of the present invention is illustrated. Although the infrastructure of the gas supply system is similar to the one shown in Fig. 1, the electrically- insulated

box 30, the electrically-insulated hard tube 40 and the flexible tube 50 all are disposed above the metal chamber 10. In this embodiment, the flexible tube 50 is placed at the top space of the facilities without the interference with the equipment located on the floor 1 similarly.

From the above description, the first end 41 of the electrically-insulated hard tube 40 of the present invention is connected to the second tube 12 and disposed in an electrically-insulated box 30, which is hung on a sidewall of the metal chamber 30. When there is vibration generated in the environment accidentally, both of the electrically-insulated box 30 and the electrically-insulated hard tube 40 are vibrated with the metal chamber 10 simultaneously. Due to the second end 42 of the electrically-insulated hard tube 40 is connected with the flexible tube 50 instead of being connected to the fixed apparatus, the energy caused from the vibration could be absorbed by the flexible tube 50 under a certain level. Take an example of the 1/8 inch diameter of the stainless tube adopted for the flexible tube 50. The stainless tube is formed as a spring shape by a regular spiral elongation. Since the spring shape stainless tube is formed as a three-dimensional component, it would provide enough flexibility while the displacement generated in three-dimensional directions. Therefore, when the dramatic shake caused by the earthquake happened, there would be enough cushion provided from the spring shape stainless tube, so that the electrically-insulated hard tube 40 would not be broken during the period of an earthquake.

Other than that, the gas supply system of the present invention could ensure that the doping gas in the electrically-insulated hard tube 40 would not be ionized by the high voltage difference during the transmittance of the doping gas to the metal chamber with high electrical potential. With reference to Fig. 4, there are Paschen curves regarding to one doping gas (BF_3). The equation of the Paschen curve is expressed as $V = f(pd)$ 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 distance between the electrodes. From the curves shown in Fig. 4, assuming the pressure of transmitting the doping gas is a constant value, it is known that the distance between the two electrodes would determine the ionization voltage that could cause the electric arc for the doping gas pressure. And the two electrodes of the present invention refer to the first end 41 and the second end 42 of the electrically-insulated hard tube 40. Hence, when the doping gas pressure in the electrically-insulated hard tube 40 maintains as a constant pressure, one can determine the length of electrically-insulated hard tube 40, d2, such that the doping gas in the electrically-insulated hard tube 40 won't be ionized that is due to the product of p*d follows Paschen law. In other words, the product of the length d2 of the electrically-insulated hard tube 40 and the pressure of the doping gas transmitted is larger than the maximum voltage for gas ionization between a first region where the first end 41 of the electrically-insulated hard tube 40 and the second tube 12 are connected and a second region where the second end 42 of the electrically-insulated hard tube 40 and the flexible tube 50 are connected.

Therefore, it is assured a safe gas delivery in the tube and the doping gas in the electrically- insulated hard tube 40 would not be ionized by the high voltage difference.

Similarly, the Paschen curve could be applied to determine the gas pressure of the doping gas transmitted by the electrically-insulated hard tube 40, so that the product of the gas pressure and the length is beyond the regime of gas ionization taking place. That is, the product of the length of the electrically-insulated hard tube 40 and the pressure of the doping gas transmitted is larger than the maximum voltage for gas ionization between the first region where the first end 41 of the electrically-insulated hard tube 40 and the second tube 12(metal) are connected and the second region where the second end 42 of the electrically-insulated hard tube 40 and the flexible tube 50(metal) are connected. Furthermore, as the second embodiment of the gas supply system of the present invention shows, the internal pressure of the electrically-insulated box 30 would be vacuumed as a measure to prevent the electric arc occurred in the electrically-insulated box 30 affected by the high voltage difference and thus raise the level of insulation. Therefore, the ionization voltage is far more beyond the maximum voltage for gas ionization between the two terminals of the insulating distance.

In addition, because the electrically-insulated box 30 is hung on a sidewall of the metal chamber 10 electrically connected to the high voltage power source with a high voltage level, it should be considered the possibility of the electric arc occurred in the electrically- insulated box 30 as well. That is to say,

the product of the length d3 of the electrically-insulated box 30 and the internal pressure is larger than the voltage for gas ionization between the first region where the first end 41 of the electrically-insulated hard tube 40 and the second tube 12 are connected and the second region where the second end 42 of the electrically-insulated hard tube 40 and the flexible tube 50 are connected. In other words, as shown in Fig. 5, the product of the length d2 of the electrically-insulated box 30 and the internal pressure falls beyond the fringe of the product of the gas pressure and the distance between the electrodes corresponding to the ionization voltage pressure. So that the inert gas (Nitrogen N_2) within the electrically-insulated box 30 would not be ionized by the high voltage difference.

In summary, the electrically-insulated hard tube 40 is disposed at the internal side of the electrically-insulated box, wherein one end of the electrically-insulated hard tube is connected with the second tube extending from the external side of the metal chamber, and the other end is connected to the flexible tube 50 extending to the internal side of the electrically-insulated box. Because the electrically-insulated box creates a high voltage barrier and the metal chamber is electrically connected to the voltage power source with high electrical potential, the present embodiment employing the electrically-insulated hard tube 40, can avoid the gas ionization happening. Meanwhile, the flexible tube 50 connected with the electrically-insulated hard tube 40 is capable of absorbing the energy of vibration generated from the environment.

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 supply system for an ion implanter, comprising:

a metal chamber electrically-connected to a high voltage power source with a high electrical potential and having:

a first tube; and

a second tube having a first end connected with the first tube and a second end of the second tube extending to an external side of the metal chamber;

multiple electrical insulators mounted at a bottom of the metal chamber and electrically connected to the high voltage power source with a low level;

an electrically-insulated box placed outside the metal chamber;

an electrically-insulated hard tube vertically disposed in the electrically-insulated box and having:

a third end connected with the second end of the second tube; and

a fourth end; and

a first flexible tube having:

a fifth end extending to an internal side of the electrically-insulated box and connected with the fourth end of the electrically-insulated hard tube; and

a sixth end connected to a huge storage tank of the doping gas;

wherein:

the electrically-insulated box has a first length and an internal pressure, wherein a product of the first length and the internal pressure is larger than a maximum voltage for gas ionization between a first region where the third end

of the electrically-insulated hard tube and the second tube of the metal chamber are connected and a second region where the fourth end of the electrically-insulated hard tube and the first flexible tube are connected; and

the electrically-insulated hard tube has a second length and a pressure of doping gas transmitted, wherein a product of the second length and the pressure of the doping gas transmitted is larger than the maximum voltage for gas ionization between the first region and the second region.

2. The gas supply system as claimed in claim 1, further comprising:

a second flexible tube connected between the third end of the electrically-insulated hard tube and the second end of the second tube;

a third tube extending to an internal side of the electrically-insulated box; and

a vacuum pump interconnected with the third tube and providing a low pressure environment in the electrically-insulated box.

3. The gas supply system as claimed in claim 1, further comprising:

a fourth tube extending to the internal side of the electrically-insulated box; and

a source of the high pressure inert gas connected to the fourth tube by a valve capable of switching over the high pressure inert gas continuously importing to the electrically-insulated box, wherein

the pressure of the source of the high pressure inert gas is larger than the pressure of the doping gas transmitted by the electrically-insulated hard tube.

4. The gas supply system as claimed in any claim of claims 1 to 3, further comprising:

a control valve of pressure monitor connected to the second tube to adjust and monitor a pressure imported of the second tube, and output a monitored pressure value.

5. The gas supply system as claimed in claim 4, wherein a pressure of the first tube is smaller than the atmosphere, whereas a pressure of the second tube is larger than the atmosphere.

6. The gas supply system as claimed in any claim of claims 1 to 3, further comprising a gas vessel storing a doping gas and connected with the first tube.

7. The gas supply system as claimed in any claim of claims 1 to 3, wherein the electrically-insulated hard tube is made of sapphire glass, ceramics or plastics; wherein the plastics include either one of the Ethylene polymer, Phthalates polymer or Sulfide polymer.

8. The gas supply system as claimed in any claim of claims 1 to 3, wherein the first and second flexible tubes are made of the stainless steel.

9. The gas supply system as claimed in any claim of claims 1 to 3, wherein the doping gas is selected from one of Arsine, Phosphine, Boron Trifluoride, Carbon Monoxide, Germanium Tetrafluoride, Silicon Tetrafluoride, Fluorine Phosphide, Nitrogen Trifluoride and Germanium Tetrahydride.

10. The gas supply system as claimed in any claim of claims 1 to 3, wherein the doping gas is composed of a first gas selected from one of the Arsine, Phosphine, Boron Trifluoride, Carbon Monoxide, Germanium Tetrafluoride, Silicon Tetrafluoride, Fluorine Phosphide, Nitrogen Trifluoride, and Germanium Tetrahydride and a second gas selected from one of the Fluorine, Carbon Dioxide, Hydrogen, Nitrogen, and Argon.

11. The gas supply system as claimed in any claim of claims 1 to 3, wherein the electrically-insulated box is hung on an external area of the metal chamber and approaching to the bottom of the metal chamber.

12. The gas supply system as claimed in any claim of claims 1 to 3, wherein the electrically-insulated box is hung on an external area of the metal chamber and approaching to a top of the metal chamber.