

GAS INLET APPARATUS FOR PROCESS CHAMBER, SEMICONDUCTOR EQUIPMENT, MOUNTING METHOD, AND DISMOUNTING METHOD

TECHNICAL FIELD

[0001] The present disclosure relates to the field of semiconductor processing technology, and in particular, to a gas inlet apparatus for a process chamber, a semiconductor equipment, a mounting method, and a dismounting method.

BACKGROUND

[0002] With the development of semiconductor equipments, requirements on stability and uniformity of plasma processing become higher and higher. Taking an etching process as an example, plasma is generated inside a chamber by means of inductive coupling of an upper electrode coil, and is used to etch a wafer uniformly. At this time, the higher the uniformity of a process gas entering a chamber system structure, the more uniform the ambient temperature, the higher the uniformity of the etching of the wafer. However, in the related technology, when the process gas enters the process chamber, the uniformity of the process gas is poor, resulting in unstable process effects.

SUMMARY

[0003] A first objective of the present disclosure is to provide a gas inlet apparatus for a process chamber, so as to solve the technical problem of poor uniformity of a process gas when entering a process chamber in the existing technology.

[0004] The gas inlet apparatus for the process chamber provided herein is applied to a semiconductor equipment and includes:

a showerhead cover plate, which is provided with first gas through holes; and

a flow guide assembly, a first shower cavity being formed by a space between the flow guide assembly and the showerhead cover plate and communicated with the first gas through holes, and second gas through holes being formed in a sidewall of the first shower

cavity and configured to communicate the first shower cavity with the process chamber; and the flow guide assembly including a temperature control plate, which is located below the showerhead cover plate and is arranged opposite to the first gas through holes.

[0005] In some technical solutions, the flow guide assembly further includes a shower ring, the second gas through holes are disposed in the shower ring, the shower ring is hermetically connected to both the showerhead cover plate and the temperature control plate, and the shower ring, the showerhead cover plate, and the temperature control plate form the first shower cavity.

[0006] In some technical solutions, the shower ring is detachably connected to both the temperature control plate and the showerhead cover plate.

[0007] In some technical solutions, the temperature control plate and the showerhead cover plate clamp the shower ring from two opposite ends of the shower ring, respectively.

[0008] In some technical solutions, the shower ring is provided with a step hole having a step end face, the step end face is hermetically connected to an upper surface of the temperature control plate, and an upper end face of the shower ring is hermetically connected to a lower surface of the showerhead cover plate.

[0009] In some technical solutions, gas inlet ends of the second gas through holes are located at an inner circumferential surface of the shower ring to be communicated with the first shower cavity, gas outlet ends of the second gas through holes are located at an end face of the shower ring away from the showerhead cover plate or an outer circumferential surface of the shower ring for gas injection into the process chamber, and the second gas through holes are uniformly distributed along a circumferential direction of the shower ring; and the second gas through holes gradually move away from a center of the temperature control plate along a direction from the gas inlet ends to the gas outlet ends of the second gas through holes.

[0010] In some technical solutions, a showerhead upper plate is hermetically connected to a top of the showerhead cover plate, a space between the showerhead upper plate and the showerhead cover plate forms a second shower cavity, upper ends of the first gas through holes are communicated with the second shower cavity, and lower ends of the first gas through holes are communicated with the first shower cavity.

[0011] In some technical solutions, along a direction from gas inlet ends to gas outlet ends of the first gas through holes, the first gas through holes gradually move away from a center of the showerhead cover plate.

[0012] In some technical solutions, the temperature control plate is provided with a cooling medium inlet and outlet shaft, which penetrates through the showerhead cover plate and fits with the showerhead cover plate.

[0013] In some technical solutions, an upper surface of the temperature control plate is provided with a first boss, the first boss is hermetically connected to the showerhead cover plate, and each cooling medium inlet and outlet shaft is respectively arranged on a respective first boss.

[0014] In some technical solutions, the upper surface of the temperature control plate is provided with a second boss, the second boss is the same as the first boss in shape and size, and the second boss and the first boss are uniformly distributed along a circumferential direction of the temperature control plate.

[0015] In some technical solutions, centers of two first bosses and a center of the temperature control plate are collinearly arranged.

[0016] In some technical solutions, the cooling medium inlet and outlet shaft is provided with a radial protrusion, which is located above the showerhead cover plate; and the gas inlet apparatus further includes a mounting clamp block, which is used when fixing an axial position of the cooling medium inlet and outlet shaft relative to the showerhead cover plate, and in a case where the mounting clamp block is in use, a lower end of the mounting clamp block abuts against an upper end face of the showerhead cover plate, and an upper end of the mounting clamp block abuts against a lower end face of the radial protrusion to support the radial protrusion.

[0017] In some technical solutions, the cooling medium inlet and outlet shaft is provided with a radial protrusion, which is located above the showerhead cover plate, a top of the cooling medium inlet and outlet shaft is configured to connect a fluid inlet pipe or a fluid outlet pipe through a first clamping block and a second clamping block which are fixedly connected to each other, the first clamping block abuts against a lower surface of the radial protrusion, and the second clamping block is hermetically connected to an upper surface of the cooling medium inlet and outlet shaft.

[0018] A second objective of the present disclosure is to provide a process chamber, so as to solve the technical problem of poor uniformity of a process gas when entering a process chamber in the existing technology.

[0019] The process chamber provided herein includes the above gas inlet apparatus for the process chamber, which is located at a top of the process chamber.

[0020] By disposing the above gas inlet apparatus for the process chamber in the process chamber, the process chamber has all advantages of the gas inlet apparatus for the process chamber accordingly, which will not be described here.

[0021] In some technical solutions, the process chamber includes a chamber body, and a dielectric cylinder and a coil which are disposed at the top of the chamber body, the coil is disposed on a radial outer side of the dielectric cylinder, and the gas inlet apparatus is disposed on the dielectric cylinder.

[0022] A third objective of the present disclosure is to provide a mounting method for the above gas inlet apparatus for the process chamber, including:

- inserting two cooling medium inlet and outlet shafts through the showerhead cover plate;
- using the mounting clamp block to abut against the upper end face of the showerhead cover plate and support the radial protrusion of one of the two cooling medium inlet and outlet shafts;

- screwing a threaded connector used for fastening one first boss and the showerhead cover plate; and

- detaching the mounting clamp block, and fixing the other first boss with a threaded connector.

[0023] A fourth objective of the present disclosure is to provide a dismounting method for the above gas inlet apparatus for the process chamber, including:

- unscrewing a threaded connector used for fastening one first boss and the showerhead cover plate;

- using the mounting clamp block to abut against the upper end face of the showerhead cover plate and support the radial protrusion of one cooling medium inlet and outlet shaft;

- unscrewing a threaded connector used for fastening the other first boss and the showerhead cover plate; and

- detaching the mounting clamp block, and separating the showerhead cover plate from the temperature control plate.

[0024] The gas inlet apparatus for the process chamber provided herein for achieving the first objective and the semiconductor equipment provided herein for achieving the second objective can produce the following beneficial effects:

- by forming the first shower cavity with the space between the flow guide assembly including the temperature control plate and the showerhead cover plate, when the gas flow enters the first shower cavity through the first gas through holes in the showerhead cover

plate, the gas flow is guided by the second gas through holes in the temperature control plate to flow radially outward, and then flows out through the second gas through holes into the process chamber. In the gas inlet apparatus, after the gas is buffered twice and is dispersed twice along a circumferential direction, a velocity of the gas is basically stable, and consistency and uniformity of gas outflow rate can be improved. The temperature control plate is configured to control a temperature of a process gas entering the process chamber to be the same as a temperature required by a process. After plasma in the process chamber contacts the showerhead cover plate and the temperature control plate, the plasma may generate heat which increases the temperature of the gas. Since a temperature of a cooling fluid in the temperature control plate is consistent with the temperature required by the process, the heat generated by the plasma is taken away by the cooling fluid when the gas flows on a surface of the temperature control plate, which can control a temperature of the temperature control plate to be as consistent as possible with a temperature of the showerhead cover plate in the gas inlet apparatus for the process chamber, and further improve uniformity of gas temperature in the gas inlet apparatus and improve temperature stability to improve process effects.

[0025] The mounting method provided herein for achieving the third objective can produce the following beneficial effects:

by adopting the above mounting method, after the two cooling medium inlet and outlet shafts are inserted through the showerhead cover plate, one of the cooling medium inlet and outlet shafts can be temporarily fixed to the showerhead cover plate with the mounting clamp block, at this time, the threaded connector used for fixing the other first boss to the showerhead cover plate can be screwed up, which improves mounting convenience. Moreover, when fixing the other first boss, the temperature control plate can be kept at an accurate position for being further fixed to the showerhead cover plate, which improves mounting precision.

[0026] The dismounting method provided herein for achieving the fourth objective can produce the following beneficial effects:

by adopting the above dismounting method, after the threaded connector used for fastening one first boss is unscrewed, the other cooling medium inlet and outlet shaft is temporarily fixed to the showerhead cover plate with the mounting clamp block, at this time, the threaded connector used for fixing the other first boss to the showerhead cover plate can

be unscrewed. Thus, the temperature control plate can be prevented from falling off from the showerhead cover plate, which improves dismounting convenience.

BRIEF DESCRIPTION OF DRAWINGS

[0027] In order to describe the technical solutions in the embodiments or the background part of the present disclosure more clearly, the drawings for the description of the embodiments or the background part will be briefly described below. Apparently, the drawings described below are just for the embodiments of the present disclosure, and other drawings can be derived by those of ordinary skill in the art from the drawings provided herein without any inventive work.

[0028] FIG. 1 is a schematic structural diagram of a gas inlet apparatus for a process chamber according to a first embodiment of the present disclosure;

[0029] FIG. 2 is a partial schematic diagram of the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0030] FIG. 3 is a schematic diagram of a cooling fluid channel in a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0031] FIG. 4 is a schematic diagram illustrating a gas inlet path in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0032] FIG. 5 is a perspective view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0033] FIG. 6 is a transparent perspective view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0034] FIG. 7 is a cross-sectional view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0035] FIG. 8 is a partial cross-sectional view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0036] FIG. 9 is a partial schematic diagram of a mounting structure for a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0037] FIG. 10 is a perspective view of a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0038] FIG. 11 is a cross-sectional view of a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure;

[0039] FIG. 12 is a schematic diagram illustrating a mounting process of a temperature control plate in the process chamber inlet apparatus according to the first embodiment of the present disclosure;

[0040] FIG. 13 is a schematic diagram illustrating a direction of current flow in the process chamber inlet apparatus according to the first embodiment of the present disclosure; and

[0041] FIG. 14 is a schematic diagram of a process chamber according to a second embodiment of the present disclosure.

[0042] Description of reference numerals:

110-showerhead cover plate; 111-first gas through hole; 110a-second shower cavity; 110b-first shower cavity;

200-temperature control plate; 210-cooling medium inlet and outlet shaft; 210a-inlet channel; 210b-outlet channel; 211-radial protrusion; 213-narrowed neck portion; 220-first boss; 230-second boss; 240-cooling channel; 250-fluid inlet; 260-fluid outlet;

300-shower ring; 310-second gas through hole; 320-step end face;

400-showerhead upper plate;

500-gas inlet block;

610-showerhead bracket; 611-lifting part; 620-dielectric cylinder; 630-coil; 640-upper electrode coil base plate;

710-mounting clamp block; 720-first clamping block; 730-second clamping block;

810-chamber body; 820-wafer carrier;

910-conductive groove; 920-seal groove.

DETAIL DESCRIPTION OF EMBODIMENTS

[0043] In order to make the above objectives, features and advantages of the present disclosure more obvious and understandable, specific embodiments of the present disclosure are described in detail below with reference to the drawings. It should be

understood that the specific embodiments described herein are only intended to explain the present disclosure, rather than limiting the present disclosure.

First Embodiment

[0044] FIG. 1 is a schematic structural diagram of a gas inlet apparatus for a process chamber according to a first embodiment of the present disclosure; FIG. 2 is a partial schematic diagram of the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; as shown in FIG. 1 and FIG. 2, the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure is applied to a semiconductor equipment and includes: a showerhead cover plate 110 and a flow guide assembly, and the showerhead cover plate 110 is provided with first gas through holes 111; a first shower cavity 110b is formed by a space between the flow guide assembly and the showerhead cover plate 110, and is communicated with the first gas through holes 111, second gas through holes 310 are formed in a sidewall of the first shower cavity 110b, and are configured to communicate the first shower cavity 110b with the process chamber; and the flow guide assembly includes a temperature control plate 200, which is located below the showerhead cover plate 110 and is arranged opposite to the first gas through holes 111. In a process, a temperature of the gas inlet apparatus is raised after plasma generated in the process chamber contacts the gas inlet apparatus, and the temperature control plate 200 is configured to control a temperature of the process gas entering the process chamber, so as to control the temperature of the process gas entering the process chamber to be a temperature required by the process.

[0045] Exemplarily, in the present embodiment, a showerhead upper plate 400 is hermetically connected to a top of the showerhead cover plate 110 at, for example, a central position of the top of the showerhead cover plate 110. More specifically, an edge of the showerhead upper plate 400 is fixedly connected to the showerhead cover plate 110 with a male threaded connector such as a screw or a bolt, and a sealing ring between the showerhead upper plate 400 and the showerhead cover plate 110 is disposed on an inner side of the male threaded connector, and a gas inlet block 500 is hermetically connected to a central position of a top of the showerhead upper plate 400. A space between the showerhead upper plate 400 and the showerhead cover plate 110 forms a second shower cavity 110a. Further, an upward concave region is provided in the middle of a lower surface of the showerhead upper plate 400; correspondingly, a downward concave region is

provided in the middle of the top of the showerhead cover plate 110, and a space between the two concave regions is the second shower cavity 110a.

[0046] Upper ends of the first gas through holes 111 are communicated with the second shower cavity 110a, and lower ends of the first gas through holes 111 are communicated with the first shower cavity 110b. In some embodiments, along a direction from gas inlet ends to gas outlet ends of the first gas through holes 111, i.e., from top to bottom, the first gas through holes 111 gradually move away from a center of the showerhead cover plate 110, that is, the gas flow diffuses radially outwards when passing through the first gas through holes 111, thereby entering the first shower cavity 110b uniformly.

[0047] The temperature control plate 200 may have various configurations, so as to control the temperature of the process gas entering the process chamber and control a temperature of the temperature control plate 200 to be as consistent as possible with a temperature of the showerhead cover plate 110 in the gas inlet apparatus, thereby improving uniformity of gas temperature in the gas inlet apparatus and improving temperature stability, which in turn improve process effects. In some embodiments, a cooling channel 240 is disposed in the temperature control plate 200, and a fluid inlet and a fluid outlet of the cooling channel 240 are configured to be communicated with a cold source for providing a cooling fluid through a fluid inlet pipe and a fluid outlet pipe, respectively. The cold source supplies the cooling fluid into the cooling channel 240 through the fluid inlet pipe, and the cooling fluid in the cooling channel 240 returns to the cold source through the fluid outlet pipe, thereby achieving circular flowing of the cooling fluid. The cooling fluid is, for example, a cooling liquid (such as water) or a cooling gas. It should be noted that the temperature control plate 200 may adopt other cooling structures in practical applications, thereby controlling the temperature of the process gas entering the process chamber and controlling the temperature of the temperature control plate 200 to be as consistent as possible with a temperature of the showerhead cover plate 110 in the gas inlet apparatus.

[0048] Exemplarily, FIG. 3 is a schematic diagram of a cooling fluid channel in a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure. As shown in FIG. 3, the temperature control plate 200 is substantially circular, and the cooling channel 240 is distributed in a serpentine shape in the temperature control plate 200. In the present embodiment, the cooling channel 240 may be distributed as follows: the fluid inlet 250 of the cooling channel 240 is disposed at a relatively outer position on a certain diameter of the temperature control plate 200, the

cooling fluid after entering the cooling channel 240 through the fluid inlet 250 first flows along a first radius in a clockwise direction shown in FIG. 3 for about 1/4 of a circle, then flows radially toward a center, flows clockwise along a second radius for about 3/4 of a circle to a region with a larger radius, flows counterclockwise along a third radius for about 1/2 of a circle to a position with a fourth radius, flows counterclockwise along the fourth radius for about 1/3 of a circle, flows radially to a position with a fifth radius, flows clockwise along the fifth radius for about 3/8 of a circle, flows to a position with a sixth radius, flows clockwise along the sixth radius for 1/2 of a circle, flows to a position with a seventh radius, flows counterclockwise along the seventh radius for 1/2 of a circle, flows to a position with an eighth radius, flows along the eighth radius for about an entire circle, and finally flows out through the fluid outlet 260, with the second radius $<$ the first radius $\leq$ the third radius $<$ the fourth radius $\leq$ the sixth radius $<$ the fifth radius $\leq$ the seventh radius $<$ a distance between the fluid inlet 250 and the center of the temperature control plate 200 = a distance between the fluid outlet 260 and the center of the temperature control plate 200 $<$ the eighth radius. That is, after entering the temperature control plate 200, the cooling fluid flows in a radius ascending manner, and a region of the temperature control plate 200 with a smaller radius is a region directly opposite to the first gas through holes 111. Thus, the cooling fluid first flows through the region which has the smaller radius and is directly opposite to the first gas through holes 111; at this time, a temperature of the cooling fluid is relatively low due to a short flow distance, and the cooling fluid may first cool the gas passing through the showerhead upper plate 400 and the first gas through holes 111. Since a temperature of the gas is raised after contacting the showerhead upper plate 400 and the showerhead cover plate 110, cooling efficiency is improved by cooling the gas with the cooling fluid with the relatively low temperature.

[0049] By forming the first shower cavity 110b with the space between the flow guide assembly including the temperature control plate 200 and the showerhead cover plate 110, when the gas flow enters the first shower cavity 110b through the first gas through holes 111 in the showerhead cover plate 110, the gas flow is guided by the second gas through holes 310 in the temperature control plate 200 to flow radially outward, and then flows out through the second gas through holes 310 into the process chamber. In the gas inlet apparatus, after the gas is buffered twice (i.e., two-stage buffering by the first shower cavity 110b and the second shower cavity 110a) and is dispersed twice (i.e., two-stage dispersion by the first gas through holes 111 and the second gas through holes 310) along a

circumferential direction, a velocity of the gas is basically stable, and consistency and uniformity of gas outflow rate can be improved. The temperature control plate 200 is configured to control the temperature of the process gas entering the process chamber to be the same as the temperature required by the process. After the plasma in the process chamber contacts the showerhead cover plate 110 and the temperature control plate 200, the plasma may generate heat which increases the temperature of the gas. Since the temperature of the cooling fluid in the temperature control plate 200 is consistent with the temperature required by the process, the heat generated by the plasma is taken away by the cooling fluid when the gas flows on a surface of the temperature control plate 200, which can control the temperature of the temperature control plate 200 to be as consistent as possible with the temperature of the showerhead cover plate 110 in the gas inlet apparatus for the process chamber, and further improve the uniformity of gas temperature in the gas inlet apparatus for the process chamber and improve the temperature stability, which in turn improve process effects.

[0050] FIG. 4 is a schematic diagram illustrating a gas inlet path in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; FIG. 5 is a perspective view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; as shown in FIG. 1, FIG. 2, FIG. 4, and FIG. 5, in an embodiment, the flow guide assembly further includes a shower ring 300, the second gas through holes 310 are disposed in the shower ring 300, the shower ring 300 is hermetically connected to both the showerhead cover plate 110 and the temperature control plate 200, and the shower ring 300, the showerhead cover plate 110, and the temperature control plate 200 form the first shower cavity 110b.

[0051] By providing the shower ring 300 hermetically connected to the showerhead cover plate 110 and the temperature control plate 200, the sealing performance of the first shower cavity 110b can be ensured, and the gas does not leak between the shower ring 300 and the temperature control plate 200 or between the shower ring 300 and the showerhead cover plate 110. Moreover, since the shower ring 300 is separately disposed, the shower ring 300 with the second gas through holes 310 which have suitable distribution density, diameters, positions, and orientations may be selected as required, that is, the shower ring 300 may be separately replaced without replacing the showerhead cover plate 110, the temperature control plate 200, and the shower ring 300 together, which reduces production cost. It can be easily understood that the shower ring 300 serves as the sidewall of the first shower

cavity 110b, that is, a space enclosed by the shower ring 300 forms the first shower cavity 110b between a lower surface of the showerhead cover plate 110 and an upper surface of the temperature control plate 200.

[0052] In another implementation, an upward annular protrusion may be disposed at an edge of the temperature control plate 200 to serve as the sidewall of the first shower cavity 110b, the second gas through holes 310 are disposed in the annular protrusion, and a top of the annular protrusion is hermetically connected to the lower surface of the showerhead cover plate 110. In fact, it may be regarded that the shower ring 300 is the annular protrusion and is integrally connected to the temperature control plate 200. Alternatively, a downward annular protrusion may be disposed on the lower surface of the showerhead cover plate 110 to serve as the sidewall of the first shower cavity 110b, the second gas through holes 310 are disposed in the annular protrusion, and a lower surface of the annular protrusion is hermetically connected to the upper surface of the temperature control plate 200. Alternatively, an upward annular protrusion may be disposed at an edge of the temperature control plate 200, and a downward annular protrusion may be disposed at the lower surface of the showerhead cover plate 110, and the two annular protrusions are hermetically connected to serve as the sidewall of the first shower cavity 110b together.

[0053] As shown in FIG. 1, FIG. 2, FIG. 4, and FIG. 5, in an embodiment, the shower ring 300 is detachably connected to both the temperature control plate 200 and the showerhead cover plate 110.

[0054] By detachably connecting the shower ring 300 to both the temperature control plate 200 and the showerhead cover plate 110, the shower ring 300 can be conveniently replaced to change parameters of the second gas through holes 310 such as size, angle, position, and distribution density, so that the gas inlet apparatus for the process chamber can be precisely adapted to different process requirements to obtain different process effects.

[0055] As shown in FIG. 1, FIG. 2, FIG. 4, and FIG. 5, in an embodiment, the temperature control plate 200 and the showerhead cover plate 110 clamp the shower ring 300 from two opposite ends of the shower ring 300, respectively.

[0056] Exemplarily, in the present embodiment, an upper surface of the shower ring 300 is directly and hermetically connected to the lower surface of the showerhead cover plate 110, in other words, the upper surface of the shower ring 300 and the lower surface of the showerhead cover plate 110 abut against each other through a sealing structure. The temperature control plate 200 applies an upward force to the shower ring 300. That is, the

temperature control plate 200 and the showerhead cover plate 110 clamp the shower ring 300 together from a lower end of the shower ring 300 (by the temperature control plate 200) and from an upper end of the shower ring 300 (by the showerhead cover plate 110), respectively. No direct fastener-based connecting structures are disposed between the shower ring 300 and the temperature control plate 200 and between the shower ring 300 and the showerhead cover plate 110.

[0057] By clamping the shower ring 300 by the temperature control plate 200 and the showerhead cover plate 110 from the two opposite ends of the shower ring 300, it is unnecessary to provide a separate connecting structure between the shower ring 300 and each of the temperature control plate 200 and the showerhead cover plate 110, so that the number of parts to be mounted or dismounted can be reduced while ensuring connection strength, and convenience of replacing the shower ring 300 can be improved.

[0058] In another implementation, the shower ring 300 may be directly and fixedly connected to the showerhead cover plate 110 with a male threaded connector such as a screw or a bolt, a sealing structure such as a sealing ring between the shower ring 300 and the showerhead cover plate 110 is disposed on a radial inner side of the male threaded connector. That is, the connection of the shower ring 300 to the showerhead cover plate 110 is independent of the connection between the temperature control plate 200 and the showerhead cover plate 110.

[0059] Alternatively, a tapered surface or a step structure which is larger at the top and smaller at the bottom may be disposed on an inner wall surface of the shower ring 300, so that the shower ring 300 may apply an upward force to the temperature control plate 200 by means of the fixed connection between the shower ring 300 and the showerhead cover plate 110, thereby fixing the temperature control plate 200.

[0060] FIG. 6 is a transparent perspective view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; FIG. 7 is a cross-sectional view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; FIG. 8 is a partial cross-sectional view of a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; and FIG. 9 is a partial schematic diagram of a mounting structure for a shower ring in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure. As shown in FIG. 6 to FIG. 9, in an embodiment, the shower ring 300 is provided with a step hole

having a step end face 320, the step end face 320 is hermetically connected to the upper surface of the temperature control plate 200, and an upper end face of the shower ring 300 is hermetically connected to the lower surface of the showerhead cover plate 110.

[0061] In the present embodiment, an axis of the step hole which is smaller at the top and larger at the bottom is consistent with an axis of the shower ring 300, and the step end face 320 is perpendicular to the step hole; correspondingly, a shape of the edge of the temperature control plate 200 corresponds to the step hole, that is, an outer circumferential surface of the edge of the temperature control plate 200 is provided with an annular flange which protrudes radially. An outer circumferential surface of the annular flange mates with an inner circumferential surface of the step hole which has a larger diameter. An upper surface of the annular flange is hermetically connected to the step end face 320. More specifically, a seal groove 920 may be disposed in the step end face 320 and/or the upper surface of the annular flange to accommodate a sealing ring such as an O-ring.

[0062] At least one of the upper surface of the shower ring 300 and the lower surface of the showerhead cover plate 110 is provided with a seal groove 920 to accommodate a sealing ring such as an O-ring, so as to achieve hermetical connection between the shower ring 300 and the showerhead cover plate 110.

[0063] By disposing the step hole in the shower ring 300, a force for clamping the shower ring 300 between the temperature control plate 200 and the showerhead cover plate 110 can be provided by means of the fixed connection between the temperature control plate 200 and the showerhead cover plate 110. Moreover, the inner circumferential surface of the step hole which has the larger diameter may also mate with the temperature control plate 200 (i.e., the outer circumferential surface of the annular flange) to achieve horizontal positioning of the shower ring 300. The shower ring 300 is concentrically arranged with the first shower cavity 110b, and an inner circumferential surface of the shower ring 300 is equidistant from a center of the first shower cavity 110b. Accordingly, radial gas flow path lengths in the first shower cavity 110b are equal, thereby improving gas flow uniformity. In addition, the sealing structure for achieving hermetical connection can provide a resilience force, so that the connection between the showerhead cover plate 110 and the temperature control plate 200 is tight and firm, and cannot easily loosen.

[0064] In another implementation, an outer circumferential surface of the temperature control plate 200 may be a tapered surface which is smaller at the top and larger at the bottom, and a corresponding portion of an inner hole of the shower ring 300 is also a

tapered hole corresponding to a taper angle of the tapered surface, which can also play a role in positioning the shower ring 300 and applying an upward force to the shower ring 300.

[0065] As shown in FIG. 6 to FIG. 9, in an embodiment, gas inlet ends of the second gas through holes 310 are located at the inner circumferential surface of the shower ring 300 to be communicated with the first shower cavity 110b, gas outlet ends of the second gas through holes 310 are located at an end face of the shower ring 300 away from the showerhead cover plate 110 or an outer circumferential surface of the shower ring 300 for gas injection into the process chamber, and the second gas through holes 310 are uniformly distributed along a circumferential direction of the shower ring 300; and the second gas through holes 310 gradually move away from the center of the temperature control plate 200 along a direction from the gas inlet ends to the gas outlet ends of the second gas through holes 310.

[0066] Exemplarily, in the present embodiment, the second gas through holes 310 may be disposed as follows: the second gas through holes 310 extend radially in an upper portion of the inner circumferential surface of the shower ring 300 and then extend obliquely along a downward and radially outward direction. In the present embodiment, the gas outlet ends of the second gas through holes 310 may be disposed at a lower end face of the shower ring 300. In another implementation, the gas outlet ends of the second gas through holes 310 may be disposed at the outer circumferential surface of the shower ring 300.

[0067] In the present embodiment, a wafer carrier for carrying a wafer may be an electrostatic chuck capable of carrying the wafer and providing a lower bias voltage. In another implementation, the wafer carrier may be a vacuum chuck or a mechanical chuck.

[0068] In the process chamber using the gas inlet apparatus for the process chamber provided in the present embodiment, a lower end face of the showerhead cover plate 110 is also configured to be mounted on a dielectric cylinder 620, and the showerhead cover plate 110 is hermetically connected to the dielectric cylinder 620. The dielectric cylinder 620 may be made of, for example, a quartz material, and may have a shape of, for example, a cone which is smaller at the top and larger at the bottom. A coil 630 is disposed on a radial outer side of the dielectric cylinder 620, a showerhead bracket 610 is disposed on a radial outer side of the coil 630, and the showerhead cover plate 110 is mounted on a top of the showerhead bracket 610. In the solution where the gas outlet ends of the second gas through holes 310 are disposed at the lower end face of the shower ring 300, compared with the

solution in which the gas outlet ends are disposed at the outer circumferential surface of the shower ring 300, distances from the gas outlet ends to an inner circumferential surface of the dielectric cylinder 620 are larger, and the uniformity of the gas flow is better.

[0069] By arranging the second gas through holes 310 in such way, the gas flow injected from the second gas through holes 310 can rapidly flow to a region close to the coil 630. If the coil 630 operates at this time, ignition is performed, and etching of the wafer is performed with the plasma. Moreover, due to the two-stage buffering by the first shower cavity 110b and the second shower cavity 110a, consistency and stability of injection velocity of the gas when entering a vacuum environment are improved; meanwhile, since the gas is subjected the two-stage diffusion by the first gas through holes 111 and the second gas through holes 310 and the second gas through holes 310 of the shower ring 300 are uniformly distributed in the circumferential direction, the gas flow can be uniformly injected out through the shower ring 300, and can flow to the region close to the dielectric cylinder 620 finally.

[0070] FIG. 10 is a perspective view of a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; FIG. 11 is a cross-sectional view of a temperature control plate in the gas inlet apparatus for the process chamber according to the first embodiment of the present disclosure; as shown in FIG. 2, FIG. 4, and FIG. 9 to FIG. 11, in an embodiment, the temperature control plate 200 is provided with a cooling medium inlet and outlet shaft 210, which penetrates through the showerhead cover plate 110 and fits with the showerhead cover plate 110.

[0071] Exemplarily, in the present embodiment, two cooling medium inlet and outlet shafts 210 are disposed on the temperature control plate 200, and each cooling medium inlet and outlet shaft 210 penetrates through the showerhead cover plate 110, and is configured to connect the fluid inlet pipe or the fluid outlet pipe. A circumferential surface of the cooling medium inlet and outlet shaft 210 fits with a through hole formed in the showerhead cover plate 110. It can be easily understood that, as shown in FIG. 2, one of the cooling medium inlet and outlet shafts 210 is provided with an inlet channel 210a having two ends communicated with the fluid inlet pipe and the fluid inlet 250 of the cooling channel 240 respectively, and the other cooling medium inlet and outlet shaft 210 is provided with an outlet channel 210b having two ends communicated with the fluid outlet pipe and the fluid outlet 260 of the cooling channel 240 respectively.

[0072] With the cooling medium inlet and outlet shafts 210 penetrating through the showerhead cover plate 110, the cooling medium inlet and outlet shafts do not need to penetrate through the outer circumferential surface or a lower surface of the temperature control plate 200, do not affect movement of the gas flow after leaving the second gas through holes 310, do not interfere with movement of the gas flow around the outer circumferential surface or the lower surface of the temperature control plate 200, and do not interfere with the coil 630. In addition, with the cooling medium inlet and outlet shafts 210 fitting with the showerhead cover plate 110, horizontal guiding and positioning of the temperature control plate 200 and the showerhead cover plate 110 is also realized, so that the temperature control plate 200 can be concentrically arranged with the showerhead cover plate 110, and thus the shower ring 300 can be concentrically arranged with the showerhead cover plate 110, so as to improve the uniformity of the gas flow.

[0073] As shown in FIG. 2, FIG. 4, FIG. 10, and FIG. 11, in an embodiment, the upper surface of the temperature control plate 200 is provided with a first boss 220, which is hermetically connected to the showerhead cover plate 110, and each cooling medium inlet and outlet shaft 210 is respectively arranged on a respective first boss 220.

[0074] In the present embodiment, an upper end face of the first boss 220 may be hermetically connected to the lower surface of the showerhead cover plate 110. Exemplarily, a seal groove 920 may be disposed in the upper end face of the first boss 220 and/or in a region of the lower surface of the showerhead cover plate 110 which corresponds to the upper end face of the first boss 220, so as to accommodate a sealing ring. More specifically, in the present embodiment, a local recess is provided in a region of the lower surface of the showerhead cover plate 110 which corresponds to the first boss 220. Certainly, it should be understood by those of ordinary skill in the art that a hole communicated with the inlet channel 210a or the outlet channel 210b in the cooling medium inlet and outlet shaft 210 is further disposed in the first boss 220, so as to communicate the inlet channel or the outlet channel in the cooling medium inlet and outlet shaft 210 with the cooling channel 240 in the temperature control plate 200.

[0075] By hermetically connecting the first boss 220 to the showerhead cover plate 110, the gas flow can be prevented from leaking from the cooling medium inlet and outlet shaft 210, so as to ensure that the gas can only be injected out from the second gas through holes 310 after entering the first shower cavity 110b.

[0076] In another implementation, sealing may be realized between an outer circumferential surface of the first boss 220 and a circumferential wall of the recess in the region of the lower surface of the showerhead cover plate 110 which corresponds to the first boss 220. Further, a seal groove 920 may be disposed in the outer circumferential surface of the first boss 220 and/or the circumferential wall of the recess to accommodate a sealing ring.

[0077] As shown in FIG. 2, FIG. 4, FIG. 10, and FIG. 11, in an embodiment, the upper surface of the temperature control plate 200 is provided with a second boss 230. Unlike the first boss 220, the second boss 230 is a dummy boss. The second boss 230 is the same as the first boss 220 in shape and size, and the second boss 230 and the first boss 220 are uniformly distributed along a circumferential direction of the temperature control plate 200.

[0078] Exemplarily, in the present embodiment, the number of first bosses 220 is two, and correspondingly, the number of second bosses 230 is also two. Moreover, a distance between each second boss 230 and the center of the temperature control plate 200 is the same as that between each first boss 220 and the center of the temperature control plate 200. More specifically, in the present embodiment, the two first bosses 220 and the two second bosses 230 are distributed on a same circumference, with any two spaced apart by a central angle of 90° , and a center of the circumference being the center of the temperature control plate 200.

[0079] When the gas flows into the first shower cavity 110b, the first bosses 220 on the temperature control plate 200 may affect the flowing of the gas along the upper surface of the temperature control plate 200. By providing the first bosses 220 and the second bosses 230 which are the same in shape and size and uniformly distributing the first bosses 220 and the second bosses 230, a plurality of uniformly distributed bosses with consistent shapes and sizes can be formed on the upper surface of temperature control plate 200 to make an impact on the gas flow uniform, which can avoid a serious impact on the uniformity of the gas flow due to the arrangement of the first bosses 220.

[0080] Certainly, the present embodiment proposes the scheme of providing the two second bosses 230, but in another implementation, three or four second bosses 230 may be provided, and correspondingly, the first bosses 220 and the second bosses 230 may be distributed on a same circumference, with any two spaced apart by a central angle of 72° or 60° . The number of the second bosses 230 should not be too much because, regardless of the fact that the second bosses 230 can improve the uniformity, too many second bosses

230 may seriously hinder the gas from flowing on the upper surface of the temperature control plate 200, which may greatly reduce flowing efficiency. Those of ordinary skill in the art can select the number of the second bosses 230 as required, which will not be described here.

[0081] As shown in FIG. 2, FIG. 4, FIG. 10, and FIG. 11, in an embodiment, the centers of the two first bosses 220 and the center of the temperature control plate 200 are collinearly arranged.

[0082] In the present embodiment, the centers of the two first bosses 220 and the center of the temperature control plate 200 are collinearly arranged, and correspondingly, the centers of the two second bosses 230 and the center of the temperature control plate 200 are also collinearly arranged. For example, a line connecting the two second bosses 230 is perpendicular to a line connecting the two first bosses 220, and an intersection point is the center of the temperature control plate 200.

[0083] By collinearly arranging the centers of the two first bosses 220 and the center of the temperature control plate 200, positioning can be realized at two relatively far positions of the temperature control plate 200 by means of bore-shaft fit between the two cooling medium inlet and outlet shafts 210 and the showerhead cover plate 110, positioning stability can be improved, a need for a cantilever-type positioning structure can be obviated, mounting precision can be improved, and the possibility that the force and the sealing performance between the shower ring 300 and the showerhead cover plate 110 are reduced due to deformation of the temperature control plate 200 can be reduced.

[0084] As shown in FIG. 9 to FIG. 11, in an embodiment, an upper surface of the first boss 220 is provided with a blind threaded hole, which is in thread fit with a threaded connector penetrating through the showerhead cover plate 110, and is located between the cooling medium inlet and outlet shaft 210 and a sealing structure between the first boss 220 and the showerhead cover plate 110.

[0085] In the present embodiment, two, four, or six blind threaded holes may be uniformly arranged in the upper surface of each first boss 220, so as to be connected to male threaded connectors such as screws or bolts which penetrate through the showerhead cover plate. The sealing structure between the first boss 220 and the showerhead cover plate 110 may be a seal groove 920 disposed in the upper surface of the first boss 220 and/or in the region of the lower surface of the showerhead cover plate 110 which corresponds to the upper surface

of the first boss 220, and a sealing ring is accommodated in the seal groove 920 to achieve the sealing between the first boss 220 and the showerhead cover plate 110.

[0086] By disposing the blind threaded holes in the first bosses 220 and fixedly connecting the blind threaded holes to the threaded connectors penetrating through the showerhead cover plate 110, the temperature control plate 200 can be fixed on the showerhead cover plate 110 after the first bosses 220 are connected to the showerhead cover plate 110, which facilitates mounting. Since the blind threaded hole is located between the cooling medium inlet and outlet shaft 210 and the sealing structure between the first boss 220 and the showerhead cover plate 110, that is, the blind threaded hole is on an inner side of the sealing structure, the sealing structure may space the threaded connector from the first shower cavity 110b, thereby avoiding leakage of the first shower cavity 110b between the first boss 220 and the showerhead cover plate 110. Moreover, since the threaded connector is located inside the sealing structure, the threaded connector does not interfere with the flowing of the gas flow along the upper surface of the temperature control plate 200, thereby ensuring that the uniformity of the gas flow is not reduced.

[0087] FIG. 12 is a schematic diagram illustrating a mounting process of a temperature control plate in the process chamber inlet apparatus according to the first embodiment of the present disclosure; as shown in FIG. 9 to FIG. 12, in an embodiment, the cooling medium inlet and outlet shaft 210 is provided with a radial protrusion 211 located above the showerhead cover plate 110, the gas inlet apparatus further includes a mounting clamp block 710, which is used when fixing an axial position of the cooling medium inlet and outlet shaft 210 relative to the showerhead cover plate 110. When the mounting clamp block 710 is in use, a lower end of the mounting clamp block 710 abuts against an upper end face of the showerhead cover plate 110, and an upper end of the mounting clamp block 710 abuts against a lower end face of the radial protrusion 211 to support the radial protrusion 211.

[0088] The mounting clamp block 710 may be a cylindrical part cut into two parts along a plane where an axis is located, that is, the mounting clamp block 710 includes a first mounting clamp sub-block and a second mounting clamp sub-block obtained by cutting along the plane where the axis is located, that is, the first mounting clamp sub-block and the second mounting clamp sub-block are both substantially semi-cylindrical. The first mounting clamp sub-block and the second mounting clamp sub-block may be connected to each other with a male threaded connector such as a screw or a bolt. When the mounting

clamp block 710 is used to fix the axial position of the cooling medium inlet and outlet shaft 210 relative to the showerhead cover plate 110, the first mounting clamp sub-block and the second mounting clamp sub-block may be moved close to each other along a radial direction of the cooling medium inlet and outlet shaft 210; and the first mounting clamp sub-block and the second mounting clamp sub-block may be fastened together with the male threaded connector after the first mounting clamp sub-block and the second mounting clamp sub-block are in contact with each other, or in a case where the first mounting clamp sub-block and the second mounting clamp sub-block cannot contact each other, a top of each of the first mounting clamp sub-block and the second mounting may just need to contact a lower surface of the radial protrusion 211.

[0089] In addition, in order to reduce an overall size and a weight of the cooling medium inlet and outlet shaft 210, the cooling medium inlet and outlet shaft 210 may be provided with a narrowed neck portion 213 under the radial protrusion 211, so as to avoid an excessive size of the radial protrusion 211 and also reduce a weight of the mounting clamp block 710.

[0090] In the present embodiment, the radial protrusion 211 may be a complete circular flange. In fact, in another implementation, the radial protrusion 211 may be formed by three radial flanges each corresponding to a central angle of 60° , and the three radial flanges are spaced apart by 60° .

[0091] By providing the mounting clamp block 710 to support the radial protrusion 211, in a process of mounting the temperature control plate 200 to the showerhead cover plate 110, after the two cooling medium inlet and outlet shafts 210 are inserted through the showerhead cover plate 110, the mounting clamp block 710 may be used to surround one cooling medium inlet and outlet shaft 210 and support the radial protrusion 211, so as to prevent the one cooling medium inlet and outlet shaft 210 from withdrawing from the showerhead cover plate 110, and temporarily fix the temperature control plate 200 to facilitate screwing of the male threaded connector to the other first boss 220. The adoption of such mounting structure facilitates improvement in operation efficiency and ensures mounting precision.

[0092] As shown in FIG. 2, FIG. 4, and FIG. 9, in an embodiment, a top of the cooling medium inlet and outlet shaft 210 is configured to connect the fluid inlet pipe or the fluid outlet pipe through a first clamping block 720 and a second clamping block 730 which are fixedly connected to each other, the first clamping block 720 abuts against the lower

surface of the radial protrusion 211, and the second clamping block 730 is hermetically connected to an upper surface of the cooling medium inlet and outlet shaft 210. The first clamping block 720 and the second clamping block 730 may be fixed, for example, with a threaded connector.

[0093] A middle region of an upper surface of the first clamping block 720 fits with the radial protrusion 211 in shape and size, the second clamping block 730 is provided with a flange part and a sleeve part, the flange part of the second clamping block 730 fits with the first clamping block 720, and the sleeve part of the second clamping block 730 may be connected to the fluid inlet pipe or the fluid outlet pipe.

[0094] In the present embodiment, the radial protrusion 211 is a complete circular flange part, in which case an implementation of the sealing between the second clamping block 730 and the cooling medium inlet and outlet shaft 210 is that a seal groove 920 is disposed in a lower surface of the second clamping block 730 and/or the upper surface of the radial protrusion 211 and has a sealing ring accommodated therein for sealing. In another implementation, the radial protrusion 211 is not a complete flange part, in which case a seal groove 920 is disposed at a position of the cooling medium inlet and outlet shaft 210 at which the radial protrusion is not provided and/or in a corresponding region of the lower surface of the second clamping block 730 to accommodate a sealing ring for sealing.

[0095] By providing the first clamping block 720 and the second clamping block 730, connection with the fluid inlet pipe and the fluid outlet pipe can be realized, so that the cooling fluid can be supplied into the temperature control plate 200 to ensure the temperature of the cooling fluid in the temperature control plate 200.

[0096] In addition, as shown in FIG. 13 which illustrates a radio frequency circuit in the present embodiment, after ignition of the plasma, a direction of current flow is as follows: the wafer carrier 820-the shower ring 300-the temperature control plate 200-the showerhead cover plate 110-the showerhead bracket 610- an upper electrode coil base plate 640-the process chamber (grounded). A conductive groove 910 is disposed between every two parts in contact with each other, and has the induced coil 630 mounted therein to ensure electric conduction. In addition, the shower ring 300 and the temperature control plate 200 are surface-treated to prevent corrosion by the plasma.

Second Embodiment

[0097] As shown in FIG. 14, a second embodiment of the present disclosure provides a process chamber, a semiconductor equipment includes the above gas inlet apparatus for the

process chamber provided in the embodiments of the present disclosure, and the gas inlet apparatus for the process chamber is located at the top of the process chamber (i.e., a chamber body 810).

[0098] By disposing the gas inlet apparatus for the process chamber in the process chamber, the process chamber has all the advantages of the gas inlet apparatus for the process chamber accordingly, which will not be described here.

[0099] In an embodiment, the process chamber includes a chamber body 810, and a dielectric cylinder 620 and a coil 630 which are disposed at the top of the chamber body 810, the coil 630 is disposed on a radial outer side of the dielectric cylinder 620, and the gas inlet apparatus for the process chamber is disposed on the dielectric cylinder 620.

[0100] Exemplarily, in the present embodiment, the dielectric cylinder 620 may be a conical quartz cylinder. In another implementation, a shape of the dielectric cylinder may be cylindrical, and a material of the dielectric cylinder is not limited to a quartz material.

[0101] With the above configuration, the gas flow in the gas inlet apparatus for the process chamber can rapidly flow to a region close to the coil 630. If the coil 630 operates at this time, ignition is performed, and etching of a wafer is performed with plasma.

Third Embodiment

[0102] As shown in FIG. 12, a third embodiment of the present disclosure provides a mounting method for the above gas inlet apparatus for the process chamber provided in the embodiments of the present disclosure, and the mounting method includes:

- inserting two cooling medium inlet and outlet shafts 210 through the showerhead cover plate 110;

- using the mounting clamp block 710 to abut against the upper end face of the showerhead cover plate 110 and support the radial protrusion 211 of one of the cooling medium inlet and outlet shafts 210;

- screwing a threaded connector used for fastening the other first boss 220 (i.e., the other first boss 220 except the first boss 220 corresponding to the mounting clamp block 710) and the showerhead cover plate 110; and

- detaching the mounting clamp block 710, and fixing the remaining first boss 220 (i.e., the first boss 220 corresponding to the mounting clamp block 710) with a threaded connector.

[0103] By adopting the above mounting method, after the two cooling medium inlet and outlet shafts 210 are inserted through the showerhead cover plate 110, one of the cooling medium inlet and outlet shafts 210 can be temporarily fixed to the showerhead cover plate

110 with the mounting clamp block 710, at this time, the threaded connector used for fixing the other first boss 220 to the showerhead cover plate 110 can be screwed up, which improves mounting convenience. Moreover, when fixing the other first boss 220, the temperature control plate 200 can be kept at an accurate position for being further fixed to the showerhead cover plate 110, which improves mounting precision.

Fourth Embodiment

[0104] As shown in FIG. 12, a fourth embodiment of the present disclosure provides a dismounting method for the above gas inlet apparatus for the process chamber provided in the embodiments of the present disclosure, and the dismounting method includes:

- unscrewing a threaded connector used for fastening one first boss 220 and the showerhead cover plate 110;

- using the mounting clamp block 710 to abut against the upper end face of the showerhead cover plate 110 and support the radial protrusion 211 of one cooling medium inlet and outlet shaft 210;

- unscrewing a threaded connector used for fastening the other first boss 220 and the showerhead cover plate 110; and

- detaching the mounting clamp block 710, and separating the showerhead cover plate 110 from the temperature control plate 200.

[0105] By adopting the above dismounting method, after the threaded connector used for fastening one first boss 220 is unscrewed, the other cooling medium inlet and outlet shaft 210 can be temporarily fixed to the showerhead cover plate 110 with the mounting clamp block 710, at this time, the threaded connector used for fixing the other first boss 220 to the showerhead cover plate 110 can be unscrewed. Thus, the temperature control plate 200 can be prevented from falling off from the showerhead cover plate 110, which improves dismounting convenience.

[0106] Further, as shown in FIG. 1, lifting parts 611 are disposed at an outer edge of a top of the showerhead bracket 610 in the present disclosure and at opposite positions along a diameter of a circumference. Exemplarily, the lifting parts 611 in the present embodiment may be downward extending columns, and the showerhead bracket 610 may be lifted up by hanging a cable or a lifting strap on the columns. The dismounting method further includes:

- detaching the gas inlet block 500, the first clamping block 720, and the second clamping block 730, and lifting up the showerhead bracket 610, the showerhead cover plate 110, the shower ring 300, the temperature control plate 200, and the showerhead upper plate 400

together by means of hoisting. Then, the showerhead cover plate 110 is separated from the temperature control plate 200 with the above dismounting method, and the temperature control plate 200 is slowly pulled downward, so that the shower ring 300 and the temperature control plate 200 may be detached together. The shower ring 300 may be replaced after being separated from the temperature control plate 200. Since the shower ring 300 has small parts and is low in cost, process parameters can be adjusted by replacing the shower rings 300 with different second gas through holes 310, which improves process adaptability.

[0107] Although the present disclosure is disclosed as above, the present disclosure is not limited to the above. Various changes and modifications can be made by those of ordinary skill in the art without departing from the spirit and scope of the present disclosure, so that the scope of the present disclosure is the scope of the appended claims.

[0108] Finally, it should be noted that the relational terms such as “first” and “second” herein are just used to distinguish one entity or operation from another entity or operation, and do not necessarily require or imply that such relationship or order actually exists between the entities or operations. Moreover, the term “include” or any other variation thereof is intended to indicate a non-exclusive inclusion, so that a process, method, article, or device, which includes a series of elements, does not only include those listed elements but also include other elements that are not explicitly listed, or the elements inherent in such process, method, article, or device. If there are no more limitations, limiting an element by “including a...” does not exclude the existence of other identical elements in the process, method, article, or device which includes the element.

[0109] In the above embodiments, the descriptions using the terms such as “up” and “down” are all based on the drawings.

[0110] The above description of the embodiments of the present disclosure can enable those of ordinary skill in the art to implement or use the present disclosure. Various modifications to these embodiments are apparent to those of ordinary skill in the art, and the general principles defined herein may be implemented in other embodiments without departing from the spirit or scope of the present disclosure.

[0111] Thus, the present disclosure is not limited to the embodiments described herein, but falls in the widest scope consistent with the principle and novel features disclosed herein.

What is claimed is:

1. A gas inlet apparatus for a process chamber applied to a semiconductor equipment, comprising:

a showerhead cover plate, which is provided with first gas through holes; and

a flow guide assembly, a first shower cavity being formed by a space between the flow guide assembly and the showerhead cover plate and communicated with the first gas through holes, and second gas through holes being formed in a sidewall of the first shower cavity and configured to communicate the first shower cavity with the process chamber; and the flow guide assembly comprising a temperature control plate, which is located below the showerhead cover plate and is arranged opposite to the first gas through holes.

2. The gas inlet apparatus for the process chamber of claim 1, wherein the flow guide assembly further comprises a shower ring, the second gas through holes are disposed in the shower ring, the shower ring is hermetically connected to both the showerhead cover plate and the temperature control plate, and the shower ring, the showerhead cover plate, and the temperature control plate form the first shower cavity.

3. The gas inlet apparatus for the process chamber of claim 2, wherein the shower ring is detachably connected to both the temperature control plate and the showerhead cover plate.

4. The gas inlet apparatus for the process chamber of claim 3, wherein the temperature control plate and the showerhead cover plate clamp the shower ring from two opposite ends of the shower ring, respectively.

5. The gas inlet apparatus for the process chamber of claim 4, wherein the shower ring is provided with a step hole having a step end face, the step end face is hermetically connected to an upper surface of the temperature control plate, and an upper end face of the shower ring is hermetically connected to a lower surface of the showerhead cover plate.

6. The gas inlet apparatus for the process chamber of claim 2, wherein gas inlet ends of the second gas through holes are located at an inner circumferential surface of the shower ring to be communicated with the first shower cavity, gas outlet ends of the second gas through holes are located at an end face of the shower ring away from the showerhead cover plate or an outer circumferential surface of the shower ring for gas injection into the process chamber, and the second gas through holes are uniformly distributed along a circumferential direction of the shower ring; and the second gas through holes gradually move away from a center of the temperature control plate along a direction from the gas inlet ends to the gas outlet ends of the second gas through holes.

7. The gas inlet apparatus for the process chamber of claim 1, wherein a showerhead upper plate is hermetically connected to a top of the showerhead cover plate, a space between the showerhead upper plate and the showerhead cover plate forms a second shower cavity, upper ends of the first gas through holes are communicated with the second shower cavity, and lower ends of the first gas through holes are communicated with the first shower cavity.

8. The gas inlet apparatus for the process chamber of claim 1, wherein along a direction from gas inlet ends to gas outlet ends of the first gas through holes, the first gas through holes gradually move away from a center of the showerhead cover plate.

9. The gas inlet apparatus for the process chamber of any one of claims 1 to 8, wherein the temperature control plate is provided with a cooling medium inlet and outlet shaft, which penetrates through the showerhead cover plate and fits with the showerhead cover plate.

10. The gas inlet apparatus for the process chamber of claim 9, wherein an upper surface of the temperature control plate is provided with a first boss, the first boss is hermetically connected to the showerhead cover plate, and each cooling medium inlet and outlet shaft is respectively arranged on a respective first boss.

11. The gas inlet apparatus for the process chamber of claim 10, wherein the upper surface of the temperature control plate is provided with a second boss, the second

boss is the same as the first boss in shape and size, and the second boss and the first boss are uniformly distributed along a circumferential direction of the temperature control plate.

12. The gas inlet apparatus for the process chamber of claim 11, wherein centers of two first bosses and a center of the temperature control plate are collinearly arranged.

13. The gas inlet apparatus for the process chamber of claim 10, wherein the cooling medium inlet and outlet shaft is provided with a radial protrusion, which is located above the showerhead cover plate; and the gas inlet apparatus further comprises a mounting clamp block, which is used when fixing an axial position of the cooling medium inlet and outlet shaft relative to the showerhead cover plate, and in a case where the mounting clamp block is in use, a lower end of the mounting clamp block abuts against an upper end face of the showerhead cover plate, and an upper end of the mounting clamp block abuts against a lower end face of the radial protrusion to support the radial protrusion.

14. The gas inlet apparatus for the process chamber of claim 9, wherein the cooling medium inlet and outlet shaft is provided with a radial protrusion, which is located above the showerhead cover plate, a top of the cooling medium inlet and outlet shaft is configured to connect a fluid inlet pipe or a fluid outlet pipe through a first clamping block and a second clamping block which are fixedly connected to each other, the first clamping block abuts against a lower surface of the radial protrusion, and the second clamping block is hermetically connected to an upper surface of the cooling medium inlet and outlet shaft.

15. A process chamber, comprising the gas inlet apparatus for the process chamber of any one of claims 1 to 14, the gas inlet apparatus for the process chamber being located at a top of the process chamber.

16. The process chamber of claim 15, wherein the process chamber comprises a chamber body, and a dielectric cylinder and a coil which are disposed at the top of the chamber body, the coil is disposed on a radial outer side of the dielectric cylinder, and

the gas inlet apparatus for the process chamber is disposed on the dielectric cylinder.

17. A mounting method for the gas inlet apparatus for the process chamber of claim 13, comprising:

inserting two cooling medium inlet and outlet shafts through the showerhead cover plate;

using the mounting clamp block to abut against the upper end face of the showerhead cover plate and support the radial protrusion of one of the two cooling medium inlet and outlet shafts;

screwing a threaded connector used for fastening one first boss and the showerhead cover plate; and

detaching the mounting clamp block, and fixing the other first boss with a threaded connector.

18. A dismounting method for the gas inlet apparatus for the process chamber of claim 13, comprising:

unscrewing a threaded connector used for fastening one first boss and the showerhead cover plate;

using the mounting clamp block to abut against the upper end face of the showerhead cover plate and support the radial protrusion of one cooling medium inlet and outlet shaft;

unscrewing a threaded connector used for fastening the other first boss and the showerhead cover plate; and

detaching the mounting clamp block, and separating the showerhead cover plate from the temperature control plate.