A SUBSTRATE COOLING UNIT AND THE SUBSTRATE TREATING FACILITY

BACKGROUND OF THE INVENTION

[0001] The present invention disclosed herein relates to a substrate treating apparatus, and more particularly, to an apparatus for cooling a substrate.

Processes for manufacturing semiconductor devices, flat display panels, solar cells, and the like include an ashing process for removing photoresist. The ashing process removes a photoresist applied on a substrate.

The ashing process is performed in a state where the substrate is heated at a temperature of about 250℃. The substrate on which the ashing process is completed is transferred to a cooling plate and then cooled. The substrate is cooled by a cooling fluid circulating inside the cooling plate. A cooling stage is maintained at temperature of about 25℃. Thus, it takes a long time to cool the substrate on which the ashing process is completed. And, when the substrate is transferred to a front opening unified pod (FOUP) in a state where the substrate is not sufficiently cooled, the substrate is left under the atmospheric pressure to thus increase a production rate of oxides.

【PRIOR ART DOCUMENTS】

【PATENT DOCUMENTS】

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SUMMARY OF THE INVENTION

[0002] The present invention provides a substrate cooling unit which restrains oxides from being produced on a substrate.

[0003] The present invention also provides a substrate cooling unit which reduces a temperature of a substrate for a short time.

[0004] Embodiments of the present invention provide substrate cooling units for cooling a substrate processed at a high temperature, the substrate cooling unit including: a housing having a space therein; a cooling plate supporting the substrate within the housing, the cooling plate having a cooling passage therein through which a cooling fluid flows; and a cooling gas supply part supplying a cooling gas into the housing.

[0005] In some embodiments, the cooling gas supply part may further include: a cooling gas storage; a cooling gas supply line having a front end connected to the housing and a rear end connected to the cooling gas storage to supply the cooling gas stored in the cooling gas storage into the housing; and a diffuser disposed on the front end of the cooling gas supply line to multidirectionally diffuse the cooling gas supplied into the housing.

[0006] In other embodiments, a hole may be defined in an upper wall of the housing facing the cooling plate, and the diffuser may have a plate shape having a surface in which apertures for spraying the cooling gas are defined, the diffuser being inserted into the hole.

[0007] In still other embodiments, the diffuser may have a rod shape and apertures for spraying the cooling gas in a surface thereof and may be disposed above the cooling plate.

[0008] In even other embodiments, the housing may include: a bottom wall disposed under the cooling plate, the bottom wall having first exhaust holes through which a gas in the housing is exhausted to the outside; and sidewalls disposed at one side of the cooling plate, the sidewall having second exhaust holes through which the

gas in the housing is exhaust to the outside, wherein each of the second exhaust holes may have a height less than that of the cooling plate.

[0009] In yet other embodiments, a plurality of gas supply holes for supplying the cooling gas to a bottom surface of the substrate may be defined in the cooling plate, and the cooling gas supply part may include: a buffer member disposed under the cooling plate, the buffer member having a buffer space connected to the gas supply holes; and a cooling gas supply line for supplying the cooling gas into the buffer space.

[0010] In further embodiments, exhaust holes for exhausting the cooling gas may be defined in an upper wall of the housing facing the cooling plate.

[0011] In still further embodiments, the substrate cooling units may further include elevation pins respectively disposed within elevation holes defined in the cooling plate, the elevation pins being elevated along the elevation holes to unload the substrate from the cooling plate, wherein the housing may have an opened bottom surface facing a top surface of the cooling plate and a lower end placed on upper ends of the elevation pins.

[0012] In even further embodiments, a top surface of each of the elevation pins may have a flat surface on which the lower end of the housing is placed and an inclined surface extending from the flat surface and inclined downward to have a height gradually decreasing toward an end thereof, thereby supporting a side portion of the substrate.

[0013] Embodiments of the present invention provide substrate treating facilities including: a load port; an equipment front end module; a load lock chamber; and a process treatment chamber, wherein the load port, the equipment front end module, the load lock chamber, and the process treatment chamber are sequentially

disposed in a line, the equipment front end module includes a transfer robot for transferring a substrate between the load port and the load lock chamber, the process treatment chamber includes a process chamber in which the substrate is heated and a carrying chamber including a carrying robot for transferring the substrate between the process chamber and the load lock chamber, and the load lock chamber includes: a first housing providing a space in which the substrate heated in the process chamber stands by before the substrate is transferred into the equipment front end module; a first cooling plate supporting the substrate in the first housing, the first cooling plate having a cooling passage through which a cooling fluid flows therein; and a first cooling gas supply part supplying a cooling gas into the first housing.

[0014] In some embodiments, the load lock chamber may further include: a second housing disposed on a side of the first housing, the second housing providing a space in which the substrate heated in the process chamber stands by before the substrate is transferred into the equipment front end module; a second cooling plate supporting the substrate in the second housing, the second cooling plate having a cooling passage through which the cooling fluid flows therein; and a second cooling gas supply part supplying the cooling gas into the second housing.

[0015] In other embodiments, the load lock chamber may further include: a third housing disposed below the first housing to provide a space in which the substrate transferred from the equipment front end module into the process treatment chamber stands by; and a fourth housing disposed below the second housing to provide a space in which the substrate transferred form the equipment front end module into the process treatment chamber stands by.

[0016] In still other embodiments, the first cooling gas supply part may include: a cooling gas supply line having a front end connected to the first housing

and a rear end connected to the cooling gas storage, the cooling gas supply line supplying the cooling gas stored in the cooling gas storage into the first housing; and a diffuser disposed on the front end of the gas supply line to multidirectionally diffuse the cooling gas supplied into the first housing.

[0017] In even other embodiments, the first cooling gas supply part may include: a cooling gas supply line having a front end connected to the first housing and a rear end connected to the cooling gas storage, the cooling gas supply line supplying the cooling gas stored in the cooling gas storage into the first housing; and a diffuser disposed on the front end of the gas supply line to multidirectionally diffuse the cooling gas supplied into the first housing.

[0018] In yet other embodiments, the first housing may include: a bottom wall disposed under the first cooling plate, the bottom wall having first exhaust holes through which a gas within the first housing is exhausted to the outside; and sidewalls disposed on a side of the first cooling plate, the sidewall having second exhaust holes through which the gas within the first housing is exhaust to the outside, wherein each of the second exhaust holes may have a height less than that of the first cooling plate.

[0019] In further embodiments, a plurality of gas supply holes for supplying the cooling gas onto a bottom surface of the substrate may be defined in the first cooling plate, and the cooling gas supply part may include: a buffer member disposed under the first cooling plate, the buffer member having a buffer space connected to the gas supply holes; and a cooling gas supply line for supplying the cooling gas into the buffer space.

[0020] In still further embodiments, the substrate treating facilities may further includes elevation pins respectively disposed within elevation holes defined

in the first cooling plate, the elevation pins being elevated along the elevation holes to unload the substrate from the cooling plate, wherein the first housing may have an opened bottom surface facing a top surface of the first cooling plate and a lower end placed on upper ends of the elevation pins.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The accompanying drawings are included to provide a further understanding of the present invention, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present invention and, together with the description, serve to explain principles of the present invention. In the drawings:

[0022] FIG. 1 is a schematic plan view of a substrate treating facility 1 according to an embodiment of the present invention;

[0023] FIG. 2 is schematic view of a load lock chamber, taken along line A-A' of FIG.1;

[0024] FIG. 3 is a partial perspective view illustrating a portion of a first substrate cooling unit of FIG. 2;

[0025] FIG. 4 is a graph illustrating a process in which a substrate is cooled according to Experimental examples of the present invention;

[0026] FIG. 5 is a schematic perspective view of a substrate cooling unit according to another embodiment of the present invention;

[0027] FIG. 6 is a schematic perspective view of a substrate cooling unit according to another embodiment of the present invention;

[0028] FIG. 7 is a schematic perspective view of a substrate cooling unit according to another embodiment of the present invention;

[0029] FIG. 8 is a view illustrating a bottom surface of a housing according to an embodiment of the present invention.

[0030] FIG. 9 is a view illustrating a bottom surface of a housing according to another embodiment of the present invention;

[0031] FIG. 10 is a perspective view illustrating a sidewall of a housing according to an embodiment of the present invention.

[0032] FIG. 11 is a cross-sectional view of a first substrate cooling unit according to another embodiment of the present invention;

[0033] FIG. 12 is a schematic view illustrating a process in which a substrate is cooled by using the substrate cooling unit of FIG. 11; and

[0034] FIG. 13 is a cross-sectional view of a substrate cooling unit according to another embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0035] Hereinafter, a substrate cooling unit and a substrate treating facility according to preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. Detailed descriptions related to well-known functions or configurations will be ruled out in order not to unnecessarily obscure subject matters of the present invention.

[0036] FIG. 1 is a schematic plan view of a substrate treating facility 1 according to an embodiment of the present invention.

[0037] Referring to FIG. 1, the substrate treating facility 1 includes a load port 10, an equipment front end module (EFEM) 20, a load lock chamber 30, and a process treatment chamber 40. The load port 10, the EFEM 20, the load lock chamber 30, and the process treatment chamber 40 are successively disposed in a

line. Hereinafter, a direction in which the load port 10, the EFEM 20, the load lock chamber 30, and the process treatment chamber 40 are disposed is referred to as a first direction X and a direction perpendicular to the first direction X when viewed from the top is referred to as a second direction Y. Also, a direction perpendicular to the first and second directions X and Y is referred to as a third direction Z.

[0038] The load port 10 is disposed on a front end of the substrate treating facility 1 and includes a plurality of support parts 6. Each of the support parts 6 is disposed in a line in the second direction Y. A carrier (e.g., a cassette, a FOUP, and the like) 4 is placed on each of the support parts 6. A substrate to be treated and a treated substrate are received in the carrier 4.

[0039] The EFEM 20 is disposed on the rear of the load port 10. The EFEM 20 includes a frame 21 and a transfer robot 25. The frame 21 is disposed between the load port 10 and the load lock chamber 30 and has a space therein. The frame 21 has a length direction parallel to the second direction Y. The transfer robot 25 is disposed within the frame 21. The transfer robot 25 moves along a transfer rail 27 disposed in the second direction Y. The transfer robot 25 transfer a substrate between the carrier 4 and the load lock chamber 30.

[0040] The load lock chamber 30 is disposed on the rear side of the EFEM 20 the load lock chamber 30 provides a space in which a substrate W to be treated stands by before the substrate W is transferred into process chambers 60 and before the treated substrate W is transferred into the EFEM 20. The inside of the load rock chamber 30 is changed into a vacuum or atmospheric state. The load lock chamber 30 prevents external contaminants from being introduced into a carrying chamber 50 and the process chambers 60. Doors 28 and 52 are installed between the load lock chamber 30 and the carrying chamber 50 and between the load lock chamber 30 and

the EFEM 20. When the substrate W moves between the EFEM 20 and load lock chamber 30, the door 52 provided between the door rock chamber 30 and the carrying chamber 50 is closed. When the substrate moves between the load lock chamber 30 and the carrying chamber 50, the door 28 provided between the door rock chamber 30 and the EFEM 20 is closed.

[0041] The process treatment chamber 40 is disposed on the rear side of the load lock chamber 30 along the first direction X. The process treatment chamber 40 includes the carrying chamber 50 and the process chambers 60.

[0042] The carrying chamber 50 has a polygonal body when viewed from the top side. The inside of the carrying chamber 50 is maintained to be a vacuum state. The load lock chamber 30 and the process chambers 60 are disposed around side portion of the carrying chamber 50. A passage 51 through which the substrate W passes is accessible is defined in a sidewall of the carrying chamber 50 adjacent to the load lock chamber 30. The passage 51 connects the carrying chamber 50 to the load lock chamber 30.

[0043] A carrying robot 53 is disposed inside the carrying chamber 50. The carrying robot 53 transfers the substrate W between the load rock chamber 40 and the process chambers 60. The carrying robot 53 transfers the standby substrate W from the load lock chamber 40 into the process chambers 60 or the treated substrate W from the process chambers 60 into the load lock chamber 40. Also, the carrying robot 53 sequentially transfers the substrate W among a plurality of the process chambers 60. According to an embodiment, the carrying chamber 50 has a quadrangular body when viewed form the top. The load lock chamber 40 is disposed on one sidewall adjacent to the EFEM 20, and the process chambers 60 are disposed continuously on the other sidewalls. The carrying chamber 50 may have various

shapes in addition to the above-described shape according to required process modules.

[0044] A predetermined process is performed to the substrate W in process chambers 60. For example, processes such as ashing, deposition, etching, and baking processes may be performed in the process chambers 60. The same process may be performed in each of the process chambers 60. Alternatively, a series of the processes may be sequentially performed on the substrate W in the process chambers 26.

[0045] The process chamber 60 includes a housing 61 and a support part 62. The housing 61 provides a space in which a process is performed. The inside of the housing 61 is maintained to be vacuum state. The support part 62 is provided in the housing 61 to support the substrate W when the process is performed. The support member 62 may have a structure in which the substrate W is fixed through mechanical clamping or using an electrostatic force. A heater (not shown) may be provided within the support member 62. The heater generates heat to raise the temperature of the substrate W to a predetermined temperature. In case of the ashing process, the substrate W is treated in a state where the substrate W is heated at a temperature of about 250℃. Two support members 62 are provided within the housing 61. The support members 72 are parallelly disposed in a side direction thereof. An entrance 63 through which the substrate W is accessible is defined in a region of the outer wall of housing 60 facing the transfer chamber 50. The entrance 63 may be opened and closed by a door 64. The entrance 63 has a width allowing which the two substrates W to pass theretrough at the same time. Alternatively, the entrance 63 may have the same number as those of the support members 62 within the housing 61. Here, each of the entrances 64 may have a width allowing one

substrate W to pass therethrough. The number of the support members 62 provided in the housing 61 may be further increased.

[0046] FIG. 2 is schematic view of the load lock chamber, taken along line A-A' of FIG. 1.

[0047] Referring to FIG. 2, the load lock chamber 30 separately receives a treated substrate W1 and an untreated substrate W2. The load lock chamber 30 includes a substrate cooling units 100a and 100b and a substrate standby units 200a and 200b.The substrate cooling units 110a and 100b receive the treated substrate W1. Also, the substrate cooling units 110a and 110b cool the substrate W1 while receiving the substrate W1. The substrate standby units 200a and 200b receive the untreated substrate W2. The substrate cooling units 100a and 100b may be disposed above the substrate standby units 200a and 200b.

[0048] According to an embodiment, two substrate cooling units 100a and 100b are provided. Here, the second substrate cooling unit 100b is disposed on a side of the first substrate cooling unit 100a. And, two substrate standby unit 200a and 200b are provided the second standby unit 200b is disposed at one side of the first standby unit 200a. The first standby unit 200a is disposed under the first substrate cooling unit 100a, and the second standby unit 200b is disposed under the second substrate cooling unit 100b.

[0049] FIG. 3 is a partial perspective view illustrating a portion of the first substrate cooling unit of FIG. 2. Referring to Figs. 2 and 3, the first substrate cooling unit 100a includes a first housing 110, a first cooling plate 120, and a first cooling gas supply part 130.

[0050] The first housing 110 provides a space in which the process treated substrate W1 stands by the first housing 110 includes a bottom wall 110a, a top wall

110b, and sidewalls 110c. The bottom wall 110a is disposed under the first cooling plate 120. The upper wall 110b is disposed above the first cooling plate and faces the bottom wall 110a. The sidewalls 110c are provided around the first cooling plate 120 to connect the upper wall 110b to the bottom wall 110a. A space is defined within the first housing 110 by combining the bottom wall 110a, the upper wall 110b, and the sidewalls 110c with each other. Holes 111 are defined in the upper wall 110b. The holes 111 are spaced apart from each other. And, first exhaust holes 112 are defined in the bottom wall 110a. The first exhaust holes 112 may be spaced apart from each other and uniformly defined in the bottom wall 110a. The second exhaust holes 113 are defined in each of the sidewalls 110c. Each of the second exhaust holes 113 may be positioned lower than that of the first cooling plate 120. A vacuum pressure may be applied to the side of the first housing the 110 through the first and second exhaust holes 112 and 113. A gas staying in the first housing 110 is exhausted to the outside through the first and second exhaust holes 112 and 113.

[0051] The first cooling plate 120 is disposed inside the first housing 110. The first cooling plate 120 has a plate shape having a radius greater than the substrate W1. The substrate W1 is placed on a top surface of the first cooling plate 120. The first cooling plate 120 is supported by support rods 125. Also, the first cooling plate 120 is spaced apart from the bottom wall 110a of the first housing 110 and disposed at a predetermined height. A cooling passage 121 is defined in the first cooling plate 120. The cooling passage 121 is connected to a cooling fluid supply part 130 to provide a passage through which a cooling fluid is circulated. The cooling passage 121 is defined in the cooling plate 120 in a spiral or ring shape. The cooling fluid circulating into the cooling passage 121 cools the first cooling plate 120 and the substrate W1. A liquid or gaseous fluid may be used as the cooling fluid.

[0052] The first cooling gas supply part 130 supplies a cooling gas into the first housing 110. The first cooling gas supply part 130 includes a gas storage part (not shown), a gas supply line 131, a gas injection tube 132, and a diffuser 135.

[0053] The gas storage part stores the cooling gas. An inert gas may be used as the cooling gas. Also, a helium (He) gas may be uses as the cooling gas. Since the helium (He) gas has thermal conductivity greater than air, the He gas has high cooling efficiency. Alternatively, a nitrogen (N_2) gas may be used as the cooling gas. Also, air may be used as the cooling gas.

[0054] The gas supply line 131 connects the first housing 110 to the gas storage part. The gas supply line 131 has a front end connected to the first housing 110 and a rear end connected to the gas storage part. According to an embodiment, the front end of the gas supply line 131 is branched into a plurality of lines, which of each is connected to the first housing 110. The gas supply line 131 may supply the cooling gas into respective regions of the first housing 110. The cooling gas stored in the gas storage part is supplied into the first housing 110 through the gas supply line 131.

[0055] The gas supply line 131 has a front end connected to the gas injection tube 132. The gas injection tube 132 is connected to the upper wall 110b of the first housing 110. A diffusion hole 133 having an inverse funnel shape is defined in a front end of the gas injection tube 132. The cooling gas supplied through the gas supply line 131 is diffused while passing through the diffusion hole 133.

[0056] The diffuser 135 is disposed on the front end of the gas supply line 131. The diffuser 135 may be provided as a plate having a small thickness. Also, the diffuser 135 is inserted into each of holes 111 defined in the upper wall 110b of the first housing 110.

[0057] The diffuser 135 may have holes on the surface thereof. The cooling gas is injected through the holes defined in the diffuser 135. While passing through the diffuser 135 the flow rate of the cooling gas is decreased and the cooling gas diffuses in all directions. When the cooling gas is supplied directly into the first housing 110 through the gas supply line 131, the cooling gas with directivity is supplied at a high flow rate. Thus, the substrate W1 may deviate from the cooling plate 120 or the substrate W1 is damaged. The cooling gas levitates the particles remaining in the first housing 110 and these particles may be supplied as a source of contaminating the substrate W1. Since the diffuser 135 reduces the flow rate of the cooling gas supplied and removes the directivity, it is possible to prevent the above-described problems caused by the cooling gas.

[0058] Referring to FIG. 2, the second substrate cooling unit 100b includes a second housing 140, a second cooling plate 150, and a second cooling gas supply part 160. The second housing 140 may have the same structure as the first housing 110, the second cooling plate 150 may have the same structure as the first cooling plate 120, and the second cooling gas supply part 160 may have the same structure as the first cooling gas supply part 130.

[0059] The first substrate standby unit 200a includes a third housing 210 and a support plate 220. The third housing 210 is disposed below the first housing 110 and provides a space in which the substrate W2 transferred from the EFEM (see reference numeral 20 in FIG. 1) to the process treatment chamber (see reference numeral 40 in FIG. 1). The support plate 220 is provided in the third housing 210. The support plate 220 supports the substrate W2.

[0060] A second substrate standby unit 200b includes a fourth housing 230 and a support plate 240. The fourth housing 230 is disposed below the first housing

140 and provides a space in which the substrate W2 transferred from the EFEM (see reference numeral 20 in FIG. 1) to the process treatment chamber (see reference numeral 40 in FIG. 1). The support plate 240 is provided in the fourth housing 230. The support plate 240 supports the substrate W2.

[0061] FIG. 4 is a graph showing a process of cooling a substrate according to Experimental examples.

[0062] Referring to FIG. 4, a horizontal axis of graph represents a cooling time (t) and a vertical axis of graph represents a substrate temperature (℃). The graph 1(I) shows a process of cooling a substrate according to Experimental example 1. In Experimental example 1, the substrate (see reference symbol W1 in FIG. 3) is cooled in a state where the cooling plate (see reference numeral 120 in FIG. 3) is maintained at a temperature of about 25℃. The graph 2(II) shows a process of cooling a substrate cooling according to Experimental example 2. In Experimental example 2, the substrate (see reference symbol W1 in FIG. 3) is cooled by supplying a cooling gas in a state where the cooling plate (see reference numeral 120 in FIG. 3) is maintained at a temperature of about 25℃. In the case where the substrate is heated at a temperature of about 25℃ within the process chamber (see reference numeral 60 in FIG. 1), the temperature of the substrate W1 when transferred to the cooling plate 120 is maintained at about 190℃. It takes about 53 seconds to reduce a temperature of the substrate W1 to a temperature of about 50℃ in graph 1 (I), whereas it takes about 5 seconds in graph 2(II). It is confirmed that the cooling effect is better in Experiential example 2 than in Experimental example 1 by 10 times or more. In Experimental example 2, the substrate W1 is cooled by the cooling stage 120 through heat conduction, and simultaneously, is forcibly cooled by the cooling gas so that the cooling may be carried out in a short time.

[0063] In Experimental example 2, since an inert gas is supplied into the housing 110, the substrate W1 may be cooled under an atmospheric pressure. In a case where the substrate W1 is cooled at atmospheric pressure, as a time during which the substrate W1 heated to a high temperature is exposed to the atmosphere is longer, a generation rate of oxide on the surface of the substrate W1 becomes higher. However, in Experimental example 2, the generation rate of oxides may be minimized in that inert gas is used as the cooling gas, and the temperature of the substrate W1 is rapidly decreased.

[0064] FIG. 5 is a schematic perspective view of a substrate cooling unit 110a' according to another embodiment of the present invention. Referring to FIG. 5, a diffuser 135' is disposed in a first housing 110. The diffuser 135' has a rod shape with a circular sectional area. Holes are defined in a surface of the diffuser 135'. A gas supply line 131' is provided inside the first housing 110 through a sidewall of the first housing 110. The cooling gas supplied through the gas supply line 131' is sprayed into the first housing 110 through the holes of the diffuser 135'. The diffuser 135' is disposed over a cooling plate 120. The diffuser 135' has a length direction parallel to that of a top surface of the cooling plate 120. According to the embodiment, two diffusers 135' are provided inside the first housing 110. One of the diffusers 135' is disposed above one side of the cooling plate 120, and the other one of diffusers 135' is disposed above the other side of the cooling plate 120. The diffusers 135' may be disposed parallel to each other.

[0065] FIG. 6 is a schematic perspective view of a substrate cooling unit according to another embodiment of the present invention. Referring to FIG. 6, unlike the substrate cooling unit 100a' shown in FIG. 5, diffusers 135" are parallel to each other over a cooling plate 120. A gas supply line 131" is provided inside a first

housing 110 through the upper wall of the first housing 110. A cooling gas supplied through the gas supply line 131" is sprayed into the housing 110 through the holes in the surface of the diffuser 135".

[0066] FIG. 7 is a schematic perspective view of a substrate cooling unit 100a° according to another embodiment of the present invention. Referring to FIG. 7, a diffuser 135° has a length direction parallel to a vertical direction. One diffuser 135° is vertically disposed at one side of the cooling plate 120, and the other diffuser 135° is vertically disposed at the other side of the cooling plate 120. The diffusers 135° are parallel to each other.

[0067] FIG. 8 is a view illustrating a bottom surface of a housing according to an embodiment of the present invention. Referring to FIG. 8, exhaust holes 112 are defined in a bottom surface 110a of the housing. The exhaust holes 112 have long slit holes, each having a length greater than a width. The plurality of exhaust holes 112 are vertically disposed to define one row. The exhaust holes 112 may be disposed in multiple lines. The exhaust holes 112 disposed in one line may be disposed between the exhaust holes 112 disposed in the lines adjacent thereto.

[0068] FIG. 9 is a view illustrating a bottom surface of a housing according to another embodiment of the present invention. Referring to FIG. 9, exhaust holes 112 defined in a bottom surface 110a of a housing have an arc shape. The exhaust holes 112 are classified into a plurality of groups. The exhaust holes 112 belonging to the same group are combined with each other to be disposed in a ring shape. The ring shapes of the respective groups have different radii and are positioned in the same center C. As the radius of the ring becomes greater, the arc size of the exhaust hole 112 belonging to the corresponding group becomes larger.

[0069] FIG. 10 is a perspective view illustrating a sidewall of a housing according to an embodiment of the present invention. Referring to FIG. 10, exhaust holes 113 are defined in a sidewall of the housing 110. The exhaust hole 113 has a circular shape. The exhaust holes 113 are provided in plurality along the sidewall of the housing 110. The exhaust hole 113 may be defined in a region adjacent to a lower portion of the housing 110.

[0070] FIG. 11 is a cross-sectional view of a first substrate cooling unit according to another embodiment. Referring to FIG. 11, a substrate cooling unit 100a includes a housing 110, a cooling plate 120, and a cooling gas supply part 130.

[0071] The housing 110 has an opened lower side and has a space therein. Exhaust holes 112 are defined in an upper wall 111 of the housing 110. The exhaust holes 112 may be defined in a central area of the upper wall 111 of the housing 110.

[0072] The cooling plate 120 is disposed under the housing 110. The upper side of the cooling plate 120 has a radius greater than that of the substrate W1. Support protrusions 121 are provided on a top surface of the cooling plate 120. The support protrusions 121 protrude from the top surface of the cooling plate 120. The support protrusions 121 protrude to a predetermined height. The substrate W1 is placed on the support protrusions 121 and spaced a predetermined distance from the top surface of the cooling plate 120.

[0073] A cooling passage 122, a gas supply hole 123, and an elevation hole 124 are defined in the cooling plate 120. The cooling passage 122 may be defined in the cooling plate 120 in a spiral or ring shape and provide a passage through which a cooling fluid is circulated. The gas supply holes 123 are provided as through-holes extending from the top surface to the bottom surface of the cooling plate 120. The gas supply holes 123 are uniformly defined throughout the cooling plate 120 and

supply the cooling gas onto the bottom surface of the substrate W1. The elevation holes 124 are defined in edge areas of the cooling plate 120. The length directions of the elevation holes 124 are parallel to a vertical direction. The elevation holes 124 are provided in plurality and are spaced apart from each other. An elevation pin 125 is disposed in each of the elevation holes 124. The elevation pin 125 moves vertically along the elevation hole 124. The upper surface of the elevation pin 125 includes a flat surface 125a and an inclined surface 125b. The areas of the flat surface 125a are flush with each other. The inclined surface 125b extends from the flat surface 125a and is inclined downward so that an end thereof has a gradually decreasing height. A lower end of the housing 110 is placed on the flat surface 125a. The lower end of the housing 110 may be fixed to the flat surface 125a of the elevation pin 125. The inclined surface supports a side portion of the substrate W1. When the elevation pins 125 move upward along the elevation holes 124, the side portion of the substrate W1 placed on the support protrusions 121 is supported by the inclined surface 125b of the elevation pin 125, and the substrate W1 is then unloaded from the cooling plate 120. Also, the side portion of the substrate W1 is placed on the inclined surface 125b of the elevation pin 125, and thus the substrate W1 is loaded on the support protrusions 121 by the elevation pin 125 descending along the elevation hole 124.

[0074] A cooling gas supply part 130 includes a buffer member 131 and a cooling gas supply line 135. The buffer member 131 is disposed below the cooling plate 120. A buffer space 132 is defined inside the buffer member 131. The buffer space 132 has a width corresponding to that of the cooling plate 120. The buffer space 132 is connected to the gas supply hole 123. The cooling gas supply line 135 is connected the buffer member 131 and supplies a cooling gas into the buffer space

132. .The cooling gas is diffused in the buffer space 132 and supplied onto the bottom of the substrate W1 through the gas supply holes 123.

[0075] FIG. 12 is a schematic view illustrating a process of cooling a substrate using the substrate cooling unit of FIG. 11.

[0076] Referring to FIG. 12, the elevation pins 125 descend along the elevation holes 124, and the substrate W1 is then placed on the support protrusions 121. A cooling fluid circulates through the cooling passage 122. Heat of the cooling fluid is transmitted into the substrate W1 to cool the substrate W1. The cooling gas supply line 135 supplies a cooling gas G into the buffer space 132. The cooling gas G diffused in the buffer space 132 is supplied onto the bottom of the substrate W1 through the gas supply holes 123. The cooling gas G moves through a space between the substrate W1 and the cooling plate 120 to be supplied to the substrate W1. The cooling gas G moves onto an upper central area of the substrate W1 and then exhausted to the outside of the housing 110 through the exhaust holes 112 defined in the upper wall 111 of the housing 110. The temperature of the heated substrate W1 may be lowered within a short time through the cooling by the cooling fluid L and the cooling by the cooling gas G.

[0077] FIG. 13 is a cross-sectional view of a substrate cooling unit according to another embodiment of the present invention. Referring to FIG. 13, unlike the embodiment of FIG. 12, exhaust holes 112 may be uniformly defined in the upper wall 111 of the housing 110. The exhaust holes 112 are uniformly defined in each area of the upper wall 111 of the housing 110. The cooling gas remaining in an upper region of the substrate W1 may be easily exhausted to the outside through the exhaust holes 112.

[0078] In the foregoing embodiments, the first and second cooling unit in FIG. 2 may be provided as the substrate cooling unit in FIG. 11 or FIG. 13.

[0079] According to embodiments of the present invention, a substrate can be cooled quickly by transferred a heat and a cooling gas within a short time.

[0080] Also, according to the embodiments of the present invention, since the substrate is in the atmosphere pressure state in a state where the substrate is sufficient low in temperature, the generation of the oxide may be restricted.

[0081] The above description is merely an illustrative description of the technical spirit of present disclosure, and those skilled in the art may change and modify the description in various ways without departing from the essential characteristics of the present disclosure. Accordingly, the embodiments and drawings disclosed in the present disclosure are not intended to limit the technical spirit of the present disclosure, but are illustrative. The scope of the technical spirit of the present disclosure is not limited by the embodiments and drawings, and the scope of the present disclosure should be interpreted based on the following appended claims. Accordingly, all technical spirits falling within an equivalent range should be construed to be included in the scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A substrate cooling unit for cooling a substrate processed at a high temperature, the substrate cooling unit comprising:

a housing having a space therein;

a cooling plate supporting the substrate within the housing, the cooling plate having a cooling passage therein through which a cooling fluid flows; and

a cooling gas supply part supplying a cooling gas into the housing.

2. The substrate cooling unit of claim 1, wherein the cooling gas supply part further comprises:

a cooling gas storage;

a cooling gas supply line having a front end connected to the housing and a rear end connected to the cooling gas storage to supply the cooling gas stored in the cooling gas storage into the housing; and

a diffuser disposed on the front end of the cooling gas supply line to multidirectionally diffuse the cooling gas supplied into the housing.

3. The substrate cooling unit of claim 2, wherein a hole is defined in an upper wall of the housing facing the cooling plate, and

the diffuser has a plate shape having a surface in which apertures for spraying the cooling gas are defined, the diffuser being inserted into the hole.

4. The substrate cooling unit of claim 2, wherein the diffuser has a rod shape and apertures for spraying the cooling gas in a surface thereof and is disposed above the cooling plate.

5. The substrate cooling unit of claim 2, wherein the housing comprises:

a bottom wall disposed under the cooling plate, the bottom wall having first exhaust holes through which a gas in the housing is exhausted to the outside; and

sidewalls disposed at one side of the cooling plate, the sidewall having second exhaust holes through which the gas in the housing is exhaust to the outside,

wherein each of the second exhaust holes has a height less than that of the cooling plate.

6. The substrate cooling unit of claim 1, wherein a plurality of gas supply holes for supplying the cooling gas to a bottom surface of the substrate are defined in the cooling plate, and

the cooling gas supply part comprises:

a buffer member disposed under the cooling plate, the buffer member having a buffer space connected to the gas supply holes; and

a cooling gas supply line for supplying the cooling gas into the buffer space.

7. The substrate cooling unit of claim 6, wherein exhaust holes for exhausting the cooling gas are defined in an upper wall of the housing facing the cooling plate.

8. The substrate cooling unit of claim 6 or 7, further comprising elevation pins respectively disposed within elevation holes defined in the cooling plate, the elevation pins being elevated along the elevation holes to unload the substrate from the cooling plate,

wherein the housing has an opened bottom surface facing a top surface of the cooling plate and a lower end placed on upper ends of the elevation pins.

9. The substrate cooling unit of claim 8, wherein a top surface of each of the elevation pins has a flat surface on which the lower end of the housing is placed and an inclined surface extending from the flat surface and inclined downward to have a height gradually decreasing toward an end thereof, thereby supporting a side portion of the substrate.

10. A substrate treating facility comprising:

a load port;

an equipment front end module;

a load lock chamber; and

a process treatment chamber,

wherein the load port, the equipment front end module, the load lock chamber, and the process treatment chamber are sequentially disposed in a line,

the equipment front end module comprises a transfer robot for transferring a substrate between the load port and the load lock chamber,

the process treatment chamber comprises a process chamber in which the substrate is heated and a carrying chamber comprising a carrying robot for transferring the substrate between the process chamber and the load lock chamber, and

the load lock chamber comprises:

a first housing providing a space in which the substrate heated in the process chamber stands by before the substrate is transferred into the equipment front end module;

a first cooling plate supporting the substrate in the first housing, the first cooling plate having a cooling passage through which a cooling fluid flows therein; and

a first cooling gas supply part supplying a cooling gas into the first housing.

11. The substrate treating facility of claim 10, wherein the load lock chamber further comprises:

a second housing disposed on a side of the first housing, the second housing providing a space in which the substrate heated in the process chamber stands by before the substrate is transferred into the equipment front end module;

a second cooling plate supporting the substrate in the second housing, the second cooling plate having a cooling passage through which the cooling fluid flows therein; and

a second cooling gas supply part supplying the cooling gas into the second housing.

12. The substrate treating facility of claim 11, wherein the load lock chamber further comprises:

a third housing disposed below the first housing to provide a space in which the substrate transferred from the equipment front end module into the process treatment chamber stands by; and

a fourth housing disposed below the second housing to provide a space in which the substrate transferred form the equipment front end module into the process treatment chamber stands by.

13. The substrate treating facility of any one of claims 10 to 12, wherein the first cooling gas supply part comprises:

a cooling gas supply line having a front end connected to the first housing and a rear end connected to the cooling gas storage, the cooling gas supply line supplying the cooling gas stored in the cooling gas storage into the first housing; and

a diffuser disposed on the front end of the gas supply line to multidirectionally diffuse the cooling gas supplied into the first housing.

14. The substrate treating facility of claim 13, wherein the first housing comprises:

a bottom wall disposed under the first cooling plate, the bottom wall having first exhaust holes through which a gas within the first housing is exhausted to the outside; and

sidewalls disposed on a side of the first cooling plate, the sidewall having second exhaust holes through which the gas within the first housing is exhaust to the outside,

wherein each of the second exhaust holes has a height less than that of the first cooling plate.

15. The substrate treating facility of any one of claims 10 to 12, wherein a plurality of gas supply holes for supplying the cooling gas onto a bottom surface of the substrate are defined in the first cooling plate, and

the cooling gas supply part comprises:

a buffer member disposed under the first cooling plate, the buffer member having a buffer space connected to the gas supply holes; and

a cooling gas supply line for supplying the cooling gas into the buffer space.

16. The substrate treating facility of any one of claims 10 to 12, further comprising elevation pins respectively disposed within elevation holes defined in the first cooling plate, the elevation pins being elevated along the elevation holes to unload the substrate from the cooling plate,

wherein the first housing has an opened bottom surface facing a top surface of the first cooling plate and a lower end placed on upper ends of the elevation pins.