

SUBSTRATE PROCESSING APPARATUS, METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE AND RECORDING MEDIUM

TECHNICAL FIELD

[0001] The present disclosure relates to a substrate processing apparatus, a method of manufacturing a semiconductor device and a recording medium.

BACKGROUND

[0002] When processing a substrate in a process of manufacturing a semiconductor device, for example, a vertical substrate processing apparatus for processing a plurality of substrates at one time is used. At the time of maintenance of the substrate processing apparatus, it is necessary to secure a maintenance area around the substrate processing apparatus. In order to secure the maintenance area, the footprint of the substrate processing apparatus may become large in some cases (for example, Patent document 1).

[Prior Art Documents]

[0003] Patent Documents

Patent Document 1: Japanese laid-open publication No. 2010-283356

[0004] The present disclosure provides some embodiments of a technique capable of reducing a footprint while securing a maintenance area.

SUMMARY

[0005] According to one embodiment of the present disclosure, there is provided a technique, including: a first processing module including a first processing container configured to process a substrate; a second processing module including a second processing container disposed adjacent to the first processing container and configured to process the substrate; a first exhaust box disposed adjacent to a back surface of the first processing module and accommodating a first exhaust system configured to evacuate an inside of the first processing

container; a first supply box disposed adjacent to a side of the first exhaust box opposite to a side adjacent to the back surface of the first processing module and accommodating a first supply system configured to supply a processing gas into the first processing container; a second exhaust box disposed adjacent to a back surface of the second processing module and accommodating a second exhaust system configured to evacuate an inside of the second processing container; and a second supply box disposed adjacent to a side of the second exhaust box opposite to a side adjacent to the back surface of the second processing module and accommodating a second supply system configured to supply a processing gas into the second processing container, wherein the first exhaust box is disposed at an outer corner positioned on a side opposite to the second processing module on the back surface of the first processing module, and the second exhaust box is disposed at an outer corner positioned on a side opposite to the first processing module on the back surface of the first processing module.

[0006] According to the present disclosure, it is possible to reduce a footprint while securing a maintenance area.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is a top view schematically showing an example of a substrate processing apparatus suitably used in an embodiment of the present disclosure.

FIG. 2 is a vertical sectional view schematically showing an example of a substrate processing apparatus suitably used in an embodiment of the present disclosure.

FIG. 3 is a vertical cross-sectional view schematically showing an example of a substrate processing apparatus suitably used in an embodiment of the present disclosure.

FIG. 4 is a vertical sectional view schematically showing an example of a process furnace suitably used in an embodiment of the present disclosure.

FIG. 5 is a horizontal sectional view schematically showing an example of a processing module suitably used in an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0008] A non-limiting exemplary embodiment of the present disclosure will now be described with reference to the drawings. Throughout the drawings, the same or corresponding components are denoted by the same or corresponding reference numerals, and redundant description thereof will be omitted. Furthermore, the side of a storage chamber 9 to be described later is referred to as a front side, and the side of transfer chambers 6A and 6B to be described later is referred to as a back side. In addition, the side facing a boundary line (adjacent surface) of processing modules 3A and 3B to be described later is referred to as an inside, and the side away from the boundary line is referred to as an outside.

[0009] In the present embodiment, the substrate processing apparatus is configured as a vertical substrate processing apparatus (hereinafter referred to as a processing apparatus) 2 that performs a substrate processing process such as a heat treatment or the like as one manufacturing process in a method of manufacturing a semiconductor device.

[0010] As shown in FIGS. 1 and 2, the processing apparatus 2 includes two adjacent processing modules 3A and 3B. The processing module 3A includes a process furnace 4A and a transfer chamber 6A. The processing module 3B includes a process furnace 4B and a transfer chamber 6B. The transfer chambers 6A and 6B are disposed under the process furnaces 4A and 4B, respectively. A transshipment chamber 8 is disposed adjacent to the front side of the transfer chambers 6A and 6B and equipped with a transshipment device 7 for transshipping a wafer W. A storage chamber 9 that stores a pod (FOUP) 5 for accommodating a plurality of wafers W is connected to the front side of the transshipment chamber 8. An I/O port 22 is installed on the entire surface of the storage chamber 9, and the pod 5 is loaded into and unloaded from the processing apparatus 2 via the I/O port 22.

[0011] On the boundary walls (adjacent surfaces) between the transfer chambers 6A and 6B and the transshipment chamber 8, gate valves 90A and 90B are respectively installed. Pressure detectors are installed in the transshipment chamber 8 and in the transfer chambers 6A and 6B, respectively. The pressure in the transshipment chamber 8 is set lower than the pressure in the transfer chambers 6A and 6B. Oxygen concentration detectors are installed

in the transshipment chamber 8 and in the transfer chambers 6A and 6B, respectively. The oxygen concentrations in the transshipment chamber 8 and in the transfer chambers 6A and 6B are kept lower than the oxygen concentration in the atmosphere. At the ceiling of the transshipment chamber 8, there is installed a clean unit 62C for supplying a clean air into the transshipment chamber 8. The clean unit 62C is configured to circulate a filtrated air, for example, an inert gas in the transshipment chamber 8. By purging the interior of the transshipment chamber 8 with a circulating inert gas, it is possible to keep the interior of the transshipment chamber 8 in a clean atmosphere. With such a configuration, it is possible to prevent particles and the like present in the transfer chambers 6A and 6B from entering the transshipment chamber 8. This makes it possible to prevent a natural oxide film from being formed on a wafer W in the transshipment chamber 8 and the transfer chambers 6A and 6B.

[0012] Since the processing module 3A and the processing module 3B have the same configuration, only the processing module 3A will be representatively described below.

[0013] As shown in FIG. 4, the process furnace 4A includes a cylindrical reaction tube 10A and a heater 12A as a heating means (heating mechanism) installed around the reaction tube 10A. The reaction tube 10A is formed of, for example, quartz or SiC. Inside the reaction tube 10A, a process chamber 14A for processing a wafer W as a substrate is formed. A temperature detection part 16A as a temperature detector is installed in the reaction tube 10A. The temperature detection part 16A is vertically installed along the inner wall of the reaction tube 10A.

[0014] A gas used for substrate processing is supplied into the process chamber 14A by a gas supply mechanism 34A as a gas supply system. The gas supplied by the gas supply mechanism 34A is changed depending on the type of the film to be formed. The gas supply mechanism 34A includes a precursor gas supply part, a reaction gas supply part and an inert gas supply part. The gas supply mechanism 34A is housed in a supply box 72A to be described later.

[0015] The precursor gas supply part includes a gas supply pipe 36a. A mass flow controller (MFC) 38a as a flow rate controller (flow rate control part) and a valve 40a as an

on-off valve are installed at the gas supply pipe 36a sequentially from the upstream side. The gas supply pipe 36a is connected to a nozzle 44a extending through a side wall of a manifold 18. The nozzle 44a is installed upright along the vertical direction within the reaction tube 10A and has a plurality of supply holes opened toward the wafers W held by a boat 26. A precursor gas is supplied to the wafer W through the supply holes of the nozzle 44a.

[0016] With the same configuration, a reaction gas is supplied from the reaction gas supply part to the wafer W via a supply pipe 36b, a MFC 38b, a valve 40b and a nozzle 44b. An inert gas is supplied from the inert gas supply part to the wafer W via supply pipes 36c and 36d, MFCs 38c and 38d, valves 40c and 40d, and nozzles 44a and 44b.

[0017] A cylindrical manifold 18A is connected to the lower end opening of the reaction tube 10A via a sealing member such as an O ring or the like to support the lower end of the reaction tube 10A. The lower end opening of the manifold 18A is opened and closed by a disk-shaped lid 22A. A sealing member such as an O-ring or the like is installed on the upper surface of the lid 22A, whereby the interior of the reaction tube 10A is hermetically sealed against the external air. A heat insulating part 24A is placed on the lid 22A.

[0018] An exhaust pipe 46A is attached to the manifold 18A. A vacuum pump 52A as a vacuum exhaust device is connected to the exhaust pipe 46A via a pressure sensor 48A as a pressure detector (pressure detection part) for detecting the pressure in the process chamber 14A and an APC (Auto Pressure Controller) valve 40A as a pressure regulator (pressure regulation part). With such a configuration, the pressure in the process chamber 14A may be set to a processing pressure depending on the process. An exhaust system A is mainly constituted by the exhaust pipe 46A, the APC valve 40A and the pressure sensor 48A. The exhaust system A is housed in an exhaust box 74A to be described later.

[0019] The process chamber 14A accommodates therein a boat 26A as a substrate holder for vertically holding a plurality of wafers W, for example, 25 to 150 wafers W in a shelf shape. The boat 26A is supported above the heat insulating part 24A by a rotating shaft 28A extending through the lid 22A and the heat insulating part 24A. The rotating shaft 28A is

connected to a rotation mechanism 30A installed below the lid 22A. The rotating shaft 28A is configured to be rotatable while hermetically sealing the inside of the reaction tube 10A. The lid 22 is vertically driven by a boat elevator 32A as an elevating mechanism. As a result, the boat 26A and the lid 22A are raised and lowered integrally, and the boat 26A is loaded into and unloaded from the reaction tube 10A.

[0020] The transshipment of the wafer W to the boat 26A is performed in the transfer chamber 6A. As shown in FIG. 3, a clean unit 60A is installed on one side surface in the transfer chamber 6A (the outer side surface of the transfer chamber 6A or the side surface opposite to the side surface facing the transfer chamber 6B). The clean unit 60A is configured to circulate a clean air (for example, an inert gas) in the transfer chamber 6A. The inert gas supplied into the transfer chamber 6A is exhausted from the inside of the transfer chamber 6A by an exhaust part 62A installed on the side surface facing the clean unit 60A across the boat 26A (the side surface facing the transfer chamber 6B) and is re-supplied from the clean unit 60A into the transfer chamber 6A (circulation purge). The pressure in the transfer chamber 6A is set to be lower than the pressure in the transshipment chamber 8. Further, the oxygen concentration in the transfer chamber 6A is set to be lower than the oxygen concentration in the atmosphere. With such a configuration, it is possible to suppress the formation of a natural oxide film on the wafer W during the transfer operation of the wafer W.

[0021] A controller 100 is connected to the rotation mechanism 30A, the boat elevator 32A, the MFCs 38a to 38d and the valves 40a to 40d of the gas supply mechanism 34A, and the APC valve 50A. The controller 100 is composed of, for example, a microprocessor (computer) having a CPU and is configured to control the operation of the processing apparatus 2. An input/output device 102 configured as, for example, a touch panel or the like is connected to the controller 100. The controller 100 may be installed for each of the processing module 3A and the processing module 3B, or one controller 100 may be installed in common in the processing module 3A and the processing module 3B.

[0022] A memory part 104 as a memory medium is connected to the controller 100. In the

memory part 104, a control program for controlling the operation of the processing apparatus 10 and a program (also referred to as a recipe) for causing each component of the processing apparatus 2 to execute a process in accordance with processing conditions are readably stored.

[0023] The memory part 104 may be a memory device (a hard disk or a flash memory) incorporated in the controller 100, or may be a portable external recording device (a magnetic tape, a magnetic disk such as a flexible disk or a hard disk, an optical disk such as a CD or a DVD, a magneto-optical disk such as an MO or the like, or a semiconductor memory such as a USB memory or a memory card). In addition, the provision of the program to the computer may be performed by using a communication means such as the Internet or a dedicated line. If necessary, the program is read out from the memory part 104 in response to an instruction from the input/output device 102, etc. The controller 100 executes a process according to the read recipe so that the processing apparatus 2 can execute a desired process under the control of the controller 100. The controller 100 is stored in controller boxes 76A and 76B.

[0024] Next, a process (film-forming process) for forming a film on a substrate by using the above-described processing apparatus 2 will be described. Description will be made on an example where a silicon oxide (SiO_2) film is formed by supplying a DCS (SiH_2Cl_2 : dichlorosilane) gas as a precursor gas and an O_2 (oxygen) gas as a reaction gas to the wafer W. In the following description, the operations of the respective parts constituting the processing apparatus 2 are controlled by the controller 100.

(Wafer Charging and Boat Loading)

[0025] The gate valve 90A is opened and the wafer W is transferred to the boat 20A. When a plurality of wafers W is loaded into the boat 26A (wafer charging), the gate valve 90A is closed. The boat 26A is loaded into the process chamber 14 by the boat elevator 32A (boat loading), and the lower opening of the reaction tube 10A is airtightly closed (sealed) by the lid 22A.

(Pressure Regulation and Temperature Adjustment)

[0026] The inside of the process chamber 14A is evacuated into vacuum (evacuated into reduced pressure) by the vacuum pump 52A so as to have a predetermined pressure (vacuum degree). The pressure in the process chamber 14A is measured by the pressure sensor 48A, and the APC valve 50 A is feedback-controlled based on the measured pressure information. Furthermore, the wafer W in the process chamber 14A is heated by the heater 12A so as to have a predetermined temperature. At this time, the supply of electric power to the heater 12A is feedback-controlled based on the temperature information detected by the temperature detection part 16A so that the process chamber 14A has a predetermined temperature distribution. In addition, the rotation of the boat 26A and the wafers W by the rotation mechanism 30A is started.

(Film-Forming Process)

[Precursor Gas Supply Step]

[0027] When the temperature in the process chamber 14A becomes stable at a preset processing temperature, a DCS gas is supplied to the wafers W in the process chamber 14A. The DCS gas is controlled to have a desired flow rate by the MFC 38a and is supplied into the process chamber 14A via the gas supply pipe 36a and the nozzle 44a.

[Precursor Gas Exhaust Step]

[0028] Next, the supply of the DCS gas is stopped, and the interior of the process chamber 14A is evacuated into vacuum by the vacuum pump 52A. At this time, an N₂ gas as inert gas may be supplied from the inert gas supply part into the process chamber 14A (inert gas purge).

[Reaction Gas Supply Step]

[0029] Next, an O₂ gas is supplied to the wafers W in the process chamber 14 A. The O₂ gas is controlled to have a desired flow rate by the MFC 38b and is supplied into the process

chamber 14A via the gas supply pipe 36b and the nozzle 44b.

[Reaction Gas Exhaust Step]

[0030] Next, the supply of the O₂ gas is stopped, and the interior of the process chamber 14A is evacuated into vacuum by the vacuum pump 52A. At this time, an N₂ gas may be supplied from the inert gas supply part into the process chamber 14A (inert gas purge).

[0031] An SiO₂ film having a predetermined composition and a predetermined film thickness can be formed on the wafer W by performing a cycle of the above-described four steps a predetermined number of times (one or more times).

(Boat Unloading and Wafer Discharging)

[0032] After forming a film having a predetermined film thickness, an N₂ gas is supplied from the inert gas supply part, the inside of the process chamber 14A is replaced with the N₂ gas, and the pressure in the process chamber 14A is restored to the atmospheric pressure. Thereafter, the lid 22A is lowered by the boat elevator 32A, and the boat 26A is unloaded from the reaction tube 10A (boat unloading). Thereafter, the processed wafers W are taken out from the boat 26A (wafer discharging).

[0033] Thereafter, the wafers W may be stored in the pod 5 and unloaded to the outside of the processing apparatus 2, or may be transferred to the process furnace 4B so that substrate processing such as, for example, annealing or the like can be continuously performed.

When continuously processing the wafers W in the process furnace 4B after the processing of the wafers W in the process furnace 4A, the gate valves 90A and 90B are opened, and the wafers W are directly transferred from the boat 26A to the boat 26B. The subsequent loading and unloading of the wafers W into and from the process furnace 4B is performed in the same procedure as the substrate processing performed by the process furnace 4A described above. Furthermore, the substrate processing in the process furnace 4B is performed, for example, in the same procedure as the substrate processing performed by the process furnace 4A described above.

[0034] As the processing conditions used when forming the SiO₂ film on the wafer W, for example, the following is exemplified.

Processing temperature (wafer temperature): 300 degrees C to 700 degrees C

Processing pressure (pressure in the process chamber): 1 Pa to 4000 Pa,

DCS gas: 100 sccm to 10,000 sccm,

O₂ gas: 100 sccm to 10,000 sccm,

N₂ gas: 100 sccm to 10,000 sccm,

By setting the respective processing conditions within the respective ranges, it becomes possible to appropriately perform the film-forming process.

[0035] Next, the rear structure of the processing apparatus 2 will be described. For example, when the boat 26 is broken, it is necessary to replace the boat 26. In addition, when the reaction tube 10 is broken or when the reaction tube 10 needs to be cleaned, it is necessary to remove the reaction tube 10. In this way, when carrying out maintenance in the transfer chamber 6 or the process furnace 4, the maintenance is performed from a maintenance area located behind the back side of the processing apparatus 2.

[0036] As shown in FIG. 1, maintenance ports 78A and 78B are formed on the back sides of the transfer chambers 6A and 6B, respectively. The maintenance port 78A is formed on the transfer chamber 6B side of the transfer chamber 6A, and the maintenance port 78B is formed on the transfer chamber 6A side of the transfer chamber 6B. The maintenance ports 78A and 78B are opened and closed by maintenance doors 80A and 80B. The maintenance doors 80A and 80B are configured to be rotatable about hinges 82A and 82B as base axes. The hinge 82A is installed on the transfer chamber 6B side of the transfer chamber 6A, and the hinge 82B is installed on the transfer chamber 6A side of the transfer chamber 6B. That is, the hinges 82A and 82B are installed adjacent to each other in the vicinity of the inner corners of the adjacent surfaces and the back sides of the transfer chambers 6A and 6B. A maintenance area is formed behind a part of the back side of the processing module 3A that is close to the processing module 3B and behind a part of the back side of the processing module 3B that is close to the processing module 3A.

[0037] As shown by phantom lines, the maintenance doors 80A and 80B are horizontally rotated about the hinges 82A and 82B to the back sides of the transfer chambers 6A and 6B, whereby the rear maintenance ports 78A and 78B are opened. The maintenance door 80A is configured to open left by 180 degrees toward the transfer chamber 6A. The maintenance door 80B is configured to open right by 180 degrees toward the transfer chamber 6B. That is, the maintenance door 80A rotates clockwise toward the transfer chamber 6A, and the maintenance door 80B rotates counterclockwise. In other words, the maintenance doors 80A and 80B are rotated in opposite directions. The maintenance doors 80A and 80B may be configured to be removable and may be removed for maintenance.

[0038] Utility systems 70A and 70B are installed in the vicinity of the back surfaces of the transfer chambers 6A and 6B. The utility systems 70A and 70B are arranged to face each other across the maintenance area interposed therebetween. The maintenance of the utility systems 70A and 70B is performed from the space (maintenance area) inside the utility systems 70A and 70B, i.e., between the utility systems 70A and 70B. The utility systems 70A and 70B are composed of exhaust boxes 74A and 74B, supply boxes 72A and 72B, and controller boxes 76A and 76B arranged sequentially from the housing side (the transfer chambers 6A and 6B side). Maintenance ports of the respective boxes of the utility systems 70A and 70B are formed on the inner side (close to the maintenance area). That is, the maintenance ports of the respective boxes of the utility systems 70A and 70B are formed to face each other.

[0039] The exhaust box 74A is disposed at an outer corner positioned behind a part of the back surface of the transfer chamber 6A opposite to the transfer chamber 6B. The exhaust box 74B is disposed at an outer corner positioned behind a part of the back side of the transfer chamber 6B opposite to the transfer chamber 6A. That is, the exhaust boxes 74A and 74B are installed flat (smoothly) such that the outer side surfaces of the transfer chambers 6A and 6B and the outer side surfaces of the exhaust boxes 74A and 74B are connected to be flush (in plane) with each other. The supply box 72A is disposed adjacent to the exhaust box 74A on the side opposite to the side of the exhaust box 74A adjacent to the

transfer chamber 6A. The supply box 72B is disposed adjacent to exhaust box 74B on the side opposite to the side of the exhaust box 74B adjacent to the transfer chamber 6B.

[0040] In a top view, the thickness (the width in the short side direction) of the exhaust boxes 74A and 74 B is smaller than the thickness of the supply boxes 72A and 72B. In other words, the supply boxes 72A and 72B protrude to the maintenance area side more than the exhaust boxes 74A and 74B. Since an integrated gas system and a large number of incidental facilities are arranged in the supply boxes 72A and 72B, the thickness may be larger than that of the exhaust boxes 72A and 72B in some cases. In such a case, by installing the exhaust boxes 72A and 72B on the housing side, it is possible to secure a large maintenance area facing the maintenance doors 80A and 80B. That is, since the distance between the exhaust boxes 74A and 74B is larger than the distance between the supply boxes 72 A and 72B in a top view, it is possible to secure a wider maintenance space when installing the exhaust boxes 74A and 74B on the housing side than when installing the supply boxes 72A and 72B on the housing side.

[0041] As shown in FIG. 3, the final valves (the valves 40a and 40b positioned at the lowermost stage of the gas supply system) of the gas supply mechanisms 34A and 34B are arranged above the exhaust boxes 74A and 74B. Preferably, the final valves are arranged just above (directly above) the exhaust boxes 74A and 74B. With such a configuration, even if the supply boxes 72A and 72B are installed away from the housing side, it is possible to shorten the pipe length from the final valves to the inside of the process chamber. This makes it possible to improve the quality of film formation.

[0042] As shown in FIG. 5, the processing modules 3A and 3B are arranged plane-symmetrically with respect to the adjacent surface S_1 of the processing modules 3A and 3B. Further, the utility systems 70A and 70B are arranged plane-symmetrically with respect to the adjacent surface S_1 . The reaction tubes 10A and 10B are installed so that each of the exhaust pipes 46A and 46B extends along the direction of the corner portion, i.e., so that the exhaust pipes 46A and 46B extend along the directions of the exhaust boxes 74A and 74B,

respectively. In addition, pipes are arranged so that the pipe length from the final valves to the nozzles becomes substantially the same in the processing modules 3A and 3B.

Moreover, as indicated by arrows in FIG. 5, the rotation directions of the wafers W are also opposite to each other in the process furnaces 4A and 4B.

[0043] Next, the maintenance of the processing apparatus 2 will be described. In the case where the inside of the transfer chamber 6A is circulation-purged by an inert gas, the interlock is set so that the maintenance door 80A cannot be opened. In addition, even when the oxygen concentration in the transfer chamber 6A is lower than the oxygen concentration at the atmospheric pressure, the interlock is set so that the maintenance door 80A cannot be opened. This also applies to the maintenance door 80B. Furthermore, when the maintenance doors 80A and 80B are opened, the interlock is set so that the gate valves 90A and 90B cannot be opened. In the case where the gate valves 90A and 90B are opened while opening the maintenance doors 80A and 80B, the entire processing apparatus 2 is brought into a maintenance mode and then the maintenance switch separately installed is turned on, whereby the interlock with respect to the gate valve 90A and 90B is released. This makes it possible to open the gate valves 90A and 90B.

[0044] When opening the maintenance door 80A, the air is caused to flow from the clean unit 62A into the transfer chamber 6A in order to raise the oxygen concentration in the transfer chamber 6A to an oxygen concentration in the atmosphere or more, preferably to an oxygen concentration in the atmosphere. At this time, the circulation purge in the transfer chamber 6A is released so that the pressure in the transfer chamber 6A does not become higher than the pressure in the transshipment chamber 8. The atmosphere in the transfer chamber 6A is exhausted to the outside of the transfer chamber 6A. The number of revolutions of a fan of the clean unit 62A is made lower than the number of revolutions during the circulation purge to control the inflow amount of the air into the transfer chamber 6A. By controlling in this way, it is possible to maintain the pressure in the transfer chamber 6A lower than the pressure in the transshipment chamber 8 while increasing the oxygen concentration in the transfer

chamber 6A.

[0045] When the oxygen concentration in the transfer chamber 6A becomes equal to the oxygen concentration in the atmospheric pressure, the interlock is released and the maintenance door 80A can be opened. At this time, even if the oxygen concentration in the transfer chamber 6A is equal to the oxygen concentration in the atmospheric pressure, when the pressure in the transfer chamber 6A is higher than the pressure in the transshipment chamber 8, the interlock is set so that the maintenance door 80A cannot be opened. When the maintenance door 80A is opened, the number of revolutions of a fan of the clean unit 62A is set to be larger than the number of revolutions at the time of the circulation purge. More preferably, the number of revolutions of the fan of the clean unit 62A is maximized.

[0046] The maintenance in the transshipment chamber 9 is performed from the maintenance port 78C formed in the front of the transshipment chamber 9 and in the portion where the pod opener is not installed. The maintenance port 78C is configured to be opened and closed by a maintenance door. As described above, when the entire processing apparatus 2 is set in the maintenance mode, the gate valves 90A and 90B are opened and the maintenance can be performed from the side of the gate valves 90A and 90B. That is, the maintenance in the transshipment chamber 8 can be performed from the front side of the apparatus, from the back side of the apparatus, or from both sides.

<Effect of the Present Embodiment>

[0047] According to the present embodiment, one or more of the following effects may be obtained.

[0048] (1) By arranging the exhaust boxes and the supply boxes from the housing side in the utility systems, it is possible to widen the maintenance area on the back side of the processing apparatus. Thus, it is possible to widely form the maintenance port on the back face of the transfer chamber, and thereby improve the maintainability. Furthermore, by widening the maintenance area on the back side of the processing apparatus, it is unnecessary to secure

maintenance areas on both sides of the apparatus. This makes it possible to reduce the footprint of the apparatus.

[0049] (2) By installing the utility systems of the right and left processing modules on both outer side surfaces of the processing apparatus so as to face each other, it is possible to use the space on the back side of the apparatus as a maintenance area common to the left and right processing modules. For example, in a conventional apparatus, a supply box and an exhaust box may be installed on both ends of the back surface of the apparatus so as to face each other. In the case where two apparatuses having such a configuration are arranged side by side, the exhaust box of one of the apparatuses and the supply box of the other apparatus are adjacent to each other on the boundary line between the two apparatuses. On the other hand, according to the present embodiment, the utility systems are not arranged on the boundary line between the two processing modules. This makes it possible to secure a wide maintenance area.

[0050] (3) By installing the final valves of the gas supply system above the exhaust boxes, it is possible to shorten the pipe length from the final valves to the process chamber. That is, it is possible to suppress gas delay, flow rate fluctuation and the like at the time of gas supply, thereby improving the quality of film formation. Usually, the quality of film formation is influenced by gas supply conditions such as a gas flow rate and a gas pressure. Therefore, it is preferable to install the supply box near the housing in order to stably supply a gas into the reaction tube. However, in the present disclosure, by installing the final valves near the reaction tube, it is possible to arrange the supply boxes at a position distant from the housing without adversely affecting the quality of film formation. Furthermore, by disposing the exhaust boxes below the exhaust pipe extending from the processing container (reaction tube) and by arranging the final valves just above the exhaust pipe, it is possible to shorten the pipe length to the process chamber. Furthermore, by installing the final valves directly above the exhaust boxes, it becomes easy to perform maintenance such as replacement of the final valves and the like.

[0051] (4) By disposing the respective components line-symmetrically with respect to the boundary between the processing modules, it is possible to suppress variations in film formation quality between the left and right processing modules. In other words, by line-symmetrically arranging the respective components in the processing modules, the utility systems, the gas supply pipes and the exhaust pipes, the pipe length from the supply boxes to the reaction tube and the pipe length from the reaction tube to the exhaust boxes can be made substantially the same between the left and right processing modules. As a result, film formation can be performed under the same conditions in the left and right processing modules, and the quality of film formation can be made uniform. Therefore, it is possible to improve the productivity.

[0052] (5) By installing the maintenance doors on the boundary side of the two processing modules and allowing the maintenance doors to rotate toward the other processing module, the maintenance door can be opened by 180 degrees, and the maintenance port can be widely formed on the back side of the transfer chamber. This makes it possible to improve the maintainability.

[0053] (6) It is possible to perform maintenance in the other processing module or the transshipment chamber while performing substrate processing in one processing module. As a result, maintenance can be performed without stopping the film-forming process. Therefore, it is possible to increase the operation rate of the apparatus and to improve the productivity.

[0054] (7) When opening the maintenance door of one processing module, the oxygen concentration in the transfer chamber is increased to the oxygen concentration at the atmospheric pressure while maintaining the pressure in the transfer chamber lower than the pressure in the transshipment chamber, whereby it is possible to suppress the inflow of the atmosphere from the transfer chamber toward the transshipment chamber. Furthermore, after the maintenance door is opened, the number of revolutions of the fan of the clean unit in the transfer chamber is made higher than that during the circulation purge, whereby even after

the maintenance door is opened (even after the transfer chamber is opened to the atmosphere), it is possible to suppress the inflow of the atmosphere from the transfer chamber toward the transshipment chamber. With such a configuration, even if the maintenance door is opened in one of the processing modules, the other processing module can be kept running. That is, even when maintenance is performed in the transfer chamber, it is possible to maintain a clean atmosphere in the transshipment chamber, and it is possible to suppress an increase in the oxygen concentration in the transshipment chamber. Therefore, the stopped processing module can be subjected to maintenance without adversely affecting the processing module under operation. As a result, the maintenance of the other processing module can be performed in a state in which one processing module is operated. Therefore, there is no need to stop the operations of all the processing apparatuses at the time of maintenance. This makes it possible to improve the productivity.

[0055] The embodiment of the present disclosure has been concretely described above.

However, the present disclosure is not limited to the above-described embodiment, and various modifications may be made without departing from the spirit thereof.

[0056] For example, in the above-described embodiment, there has been described an example in which the DCS gas is used as a precursor gas. However, the present disclosure is not limited to such an example. For example, as the precursor gas, in addition to the DCS gas, it may be possible to use an inorganic halosilane precursor gas such as a HCD (Si_2Cl_6 : hexachlorodisilane) gas, a MCS (SiH_3Cl : monochlorosilane) gas, a TCS (SiHCl_3 : trichlorosilane) gas or the like, a halogen-group-free amino (amine)-based silane precursor gas such as a 3DMAS ($\text{Si}[\text{N}(\text{CH}_3)_2]_3\text{H}$: trisdimethylaminosilane) gas, a BTBAS ($\text{SiH}_2[\text{NH}(\text{C}_4\text{H}_9)]_2$: bis-tertiary butyl aminosilane) gas or the like, and a halogen-group-free inorganic silane precursor gas such as a MS (SiH_4 : monosilane) gas, a DS (Si_2H_6 : disilane) gas or the like.

[0057] For example, in the above-described embodiment, there has been described an example in which the SiO_2 film is formed. However, the present disclosure is not limited to

such an example. For example, alternatively or additionally, a SiN film, a SiON film, a SiOCN film, a SiOC film, a SiCN film, a SiBN film, a SiBCN film or the like may be formed by using a nitrogen (N)-containing gas (nitriding gas) such as an ammonia (NH₃) gas or the like, a carbon (C)-containing gas such as a propylene (C₃H₆) gas or the like, a boron (B)-containing gas such as a boron trichloride (BCl₃) gas or the like, and so forth. Even in the case of forming these films, film formation may be performed under the same processing conditions as in the above-described embodiment, and the effects as those of the above-described embodiment may be obtained.

[0058] Further, for example, the present disclosure may also be suitably applied to a case where a film containing a metal element such as titanium (Ti), zirconium (Zr), hafnium (Hf), tantalum (Ta), niobium (Nb), aluminum (Al), molybdenum (Mo), tungsten (W) or the like, i.e., a metal-based film is formed on the wafer W.

[0059] In the above-described embodiment, there has been described an example where a film is deposited on the wafer W. However, the present disclosure is not limited to such an example. For example, the present disclosure may also be suitably applied to a case where a process such as an oxidation process, a diffusion process, an annealing process, an etching process or the like is performed on a wafer W or a film formed on the wafer W.

[0060] In addition, the above-described embodiment and modifications may be used in combination as appropriate. The processing conditions at this time may be, for example, the same processing conditions as those of the above-described embodiment and modifications.

EXPLANATION OF REFERENCE NUMERALS

[0061] 3: processing module, 72: supply box, 74: exhaust box, 76: controller box

WHAT IS CLAIMED IS:

1. A substrate processing apparatus, comprising:
 - a first processing module including a first processing container configured to process a substrate;
 - a second processing module including a second processing container disposed adjacent to the first processing container and configured to process the substrate;
 - a first exhaust box disposed adjacent to a back surface of the first processing module and accommodating a first exhaust system configured to evacuate an inside of the first processing container;
 - a first supply box disposed adjacent to a side of the first exhaust box opposite to a side adjacent to the back surface of the first processing module and accommodating a first supply system configured to supply a processing gas into the first processing container;
 - a second exhaust box disposed adjacent to a back surface of the second processing module and accommodating a second exhaust system configured to evacuate an inside of the second processing container; and
 - a second supply box disposed adjacent to a side of the second exhaust box opposite to a side adjacent to the back surface of the second processing module and accommodating a second supply system configured to supply a processing gas into the second processing container,wherein the first exhaust box is disposed at an outer corner positioned on a side opposite to the second processing module on the back surface of the first processing module, and the second exhaust box is disposed at an outer corner positioned on a side opposite to the first processing module on the back surface of the first processing module.
2. The apparatus of Claim 1, wherein the first exhaust box and the second exhaust box are disposed to face each other across a maintenance area, which is located on a side of the

second processing module on the back surface of the first processing module and on a side of the first processing module on the back surface of the second processing module, and the first supply box and the second supply box are disposed to face each other across the maintenance area.

3. The apparatus of Claim 1, wherein the first processing module further includes a first transfer chamber disposed below the first processing container, the substrate being loaded into and unloaded from the first processing container,

the second processing module further includes a second transfer chamber disposed adjacent to the first transfer chamber, the substrate being loaded into and unloaded from the second processing container,

the first exhaust box is installed adjacent to the first transfer chamber,

the second exhaust box is installed adjacent to the second transfer chamber,

the first exhaust box is disposed at an outer corner located opposite to the second transfer chamber on a back surface of the first transfer chamber, and

the second exhaust box is disposed at an outer corner located opposite to the first transfer chamber on a back surface of the second transfer chamber.

4. The apparatus of Claim 1, wherein a distance between the first exhaust box and the second exhaust box is larger than a distance between the first supply box and the second supply box.

5. The apparatus of Claim 2, wherein the first supply box protrudes toward the maintenance area more than the second exhaust box, and the second supply box protrudes toward the maintenance area more than the first exhaust box.

6. The apparatus of Claim 5, wherein a maintenance port of the first exhaust box and a maintenance port of the second exhaust box are disposed on a side of the maintenance area so as to face each other, and the maintenance port of the first exhaust box and a maintenance port of the second supply box are disposed on a side of the maintenance area so as to face each other.

7. The apparatus of Claim 3, wherein a first maintenance door is installed on a side of the second transfer chamber on a back surface of the first transfer chamber, and a second maintenance door is installed on a side of the first transfer chamber on a back surface of the second transfer chamber.

8. The apparatus of Claim 7, wherein the first maintenance door is configured to be rotatable about a side of the second transfer chamber as a base axis, and the second maintenance door is configured to be rotatable about a side of the first transfer chamber as a base axis.

9. The apparatus of Claim 8, wherein a valve located at the most downstream side of the first supply system is disposed above the first exhaust box (it is better to describe in the specification not only upward but also directly above or just above), and a valve located at the most downstream side of the second supply system is disposed above the second exhaust box (it is better to describe in the specification not only upward but also directly above or just above).

10. The apparatus of Claim 9, wherein a component in the first storage container and a component in the first transfer chamber, and a component in the second storage container and a component in the second transfer chamber, are plane-symmetrically disposed with respect to a surface adjacent to the first transfer chamber and the second transfer chamber.

11. The apparatus of Claim 10, further comprising a transshipment chamber disposed adjacent to a front side of the first transfer chamber and a front side of the second transfer chamber, the substrate being transshipped to a first substrate holder in the first transfer chamber and a second substrate holder in the second transfer chamber,

wherein the first maintenance door is configured to be opened when a pressure in the first transfer chamber is lower than a pressure in the transshipment chamber and an oxygen concentration in the first transfer chamber is equal to or higher than an oxygen concentration in the atmosphere.

12. A method of manufacturing a semiconductor device, comprising:

a first processing process of processing a substrate by evacuating an inside of a first processing container by a first exhaust system accommodated in a first exhaust box, while supplying a gas to the substrate in the first processing container of a first processing module from a first supply system disposed adjacent to a side of the first exhaust box opposite to a side adjacent to a back surface of the first processing module, the first exhaust box being disposed adjacent to the first processing module at an outer corner located on a side opposite to a second processing module adjacent to the first processing module on the back surface of the first processing module, and the first supply system being accommodated in a first supply box for supplying a processing gas into the first processing container;

a process of transferring the substrate from the first processing container to a second processing container adjacent to the first processing container via a transshipment chamber;
and

a second processing process of processing the substrate by evacuating an inside of the second processing container by a second exhaust system accommodated in a second exhaust box, while supplying a gas to the substrate in the second processing container of the second processing module from a second supply system disposed adjacent to a side of the

second exhaust box opposite to a side adjacent to a back surface of the second processing module, the second exhaust box being disposed adjacent to the second processing module at an outer corner located on a side opposite to the first processing module on the back surface of the second processing module, and the second supply system being accommodated in a second supply box for supplying a processing gas into the second processing container.

13. The method of Claim 12, further comprising a process of performing maintenance of a first transfer chamber disposed below the first processing container,

wherein the process of performing maintenance and the second processing process are performed at the same time.

14. The method of Claim 13, wherein the process of performing maintenance includes:

a step of increasing an oxygen concentration in the first transfer chamber to an oxygen concentration in the atmosphere or more, while maintaining a pressure in the first transfer chamber lower than a pressure in the transshipment chamber; and

a step of opening a maintenance door formed on a back surface of the first transfer chamber.

15. A recording medium storing a program that causes a computer to have a substrate processing apparatus perform:

a process of forming a film on a substrate by evacuating an inside of a first processing container by a first exhaust system accommodated in a first exhaust box, while supplying a gas to the substrate in the first processing container of a first processing module from a first supply system disposed adjacent to a side of the first exhaust box opposite to a side adjacent to a back surface of the first processing module, the first exhaust box being disposed adjacent to the first processing module at an outer corner located on a side opposite to a second processing module adjacent to the first processing module on the back surface of

the first processing module, and the first supply system being accommodated in a first supply box for supplying a processing gas into the first processing container;

a process of transferring the substrate from the first processing container to a second processing container adjacent to the first processing container via a transshipment chamber;
and

a process of forming a film on the substrate by evacuating an inside of the second processing container by a second exhaust system accommodated in a second exhaust box, while supplying a gas to the substrate in the second processing container of the second processing module from a second supply system disposed adjacent to a side of the second exhaust box opposite to a side adjacent to a back surface of the second processing module, the second exhaust box being disposed adjacent to the second processing module at an outer corner located on a side opposite to the first processing module on the back surface of the second processing module, and the second supply system being accommodated in a second supply box for supplying a processing gas into the second processing container.