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Substrate processing apparatus with cleaning of exhaust system

Abstract

There is provided a technique that includes: a process container processing one or more substrates; a support installed inside the process container and supporting the substrates; a first gas supplier capable of supplying gas in the process container; a second gas supplier capable of supplying in the process container; an exhaust buffer structure installed along outer circumference of the support; a third gas supplier capable of supplying first cleaning gas to the exhaust buffer structure; a fourth gas supplier capable of supplying second cleaning gas onto the support; and a controller configured to control the third and fourth gas suppliers to control a frequency or number of times for supplying each of the first and the second cleaning gas, or a supply time of each of the first and second cleaning gases, such that over-etching in the exhaust buffer structure or in the support is prevented.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2021-033215, filed on Mar. 3, 2021, the entire contents of which are incorporated

herein by reference.

TECHNICAL FIELD

(2) The present disclosure relates to a substrate processing apparatus.

BACKGROUND

(3) In the related art, as a substrate processing apparatus used in a semiconductor device manufacturing process, for example, there is an apparatus configured to arrange a plurality of substrates in a circumferential direction and perform a predetermined process (film-forming process or the like) on each of the substrates by sequentially supplying a first gas and a second gas to each of the substrates.

SUMMARY

(4) Some embodiments of the present disclosure provide a technique capable of improving a cleaning efficiency of an exhaust system against a possibility that a first gas and a second gas may be mixed when exhausting supplied gases.

(5) According to some embodiments of the present disclosure, there is provided a technique that includes: a process container configured to process one or more substrates; a support installed inside the process container and configured to support the one or more substrates on a plane of the support; a first gas supplier configured to be capable of supplying a first gas to a first domain set in the process container; a second gas supplier configured to be capable of supplying a second gas to a second domain set in the process container; an exhaust buffer structure installed along an outer circumference of the support; a first gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the first gas supplied from the first gas supplier; a second gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the second gas supplied from the second gas supplier; and a third gas supplier configured to be capable of supplying a cleaning gas to the exhaust buffer structure.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the present disclosure.

(2) FIG. **1** is a schematic view of a cross section of a substrate processing apparatus according to embodiments of the present disclosure as viewed from above.

(3) FIG. **2** is a schematic view of vertical section of a substrate processing apparatus according to embodiments of the present disclosure, which is taken along a line α-α′ in FIG. **1**.

(4) FIG. **3** is a schematic view of vertical section of a substrate processing apparatus according to embodiments of the present disclosure, which is taken along a line β-β′ in FIG. **1**.

(5) FIG. **4** is an explanatory diagram showing a configuration example of a substrate support mechanism in a substrate processing apparatus according to embodiments of the present disclosure.

(6) FIGS. **5**A to **5**E are explanatory diagrams illustrating configuration examples of a gas supplier in a substrate processing apparatus according to embodiments of the present disclosure.

(7) FIG. **6** is a block diagram showing an example of a functional configuration of a controller in a substrate processing apparatus according to embodiments of the present disclosure.

(8) FIG. **7** is a flowchart showing an example of a procedure of a substrate processing process executed by a substrate processing apparatus according to the embodiments of the present disclosure.

DETAILED DESCRIPTION

(9) Reference will now be made in detail to various embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth to provide a thorough understanding of the present disclosure. However, it will

be apparent to one of ordinary skill in the art that the present disclosure may be practiced without these specific details. In other instances, well-known methods, procedures, systems, and components are described in detail so as not to obscure aspects of the various embodiments.
(10) Hereinafter, embodiments of the present disclosure will be described with reference to the drawings.
(1) Configuration of Substrate Processing Apparatus
(11) A configuration of a substrate processing apparatus according to embodiments of the present disclosure will be described mainly with reference to FIGS. **1**, **2**, **3** and **4**. The drawings used in the following description are schematic. Dimensional relationships among the respective elements shown in the drawings, ratios of the respective elements, and the like may not match actual ones. Further, even among the drawings, dimensional relationships among the respective elements, ratios of the respective elements, and the like may not match.
(12) FIG. **1** is a schematic view of cross section of a substrate processing apparatus **200** according to embodiments of the present disclosure as viewed from above. FIG. **2** is a schematic view of vertical section of the substrate processing apparatus **200** according to the embodiments of the present disclosure, which is taken along a line α-α′ in FIG. **1**. The line α-α′ is a line extending from α to α′ via a center of a chamber **302**. FIG. **3** is a schematic view of vertical section of the substrate processing apparatus **200** according to the embodiments of the present disclosure, which is taken along a line β-β′ in FIG. **1**. The line β-β′ is a line extending from δ to δ′ via the center of a chamber **302**. FIG. **4** is an explanatory diagram showing a configuration example of a substrate support mechanism in the substrate processing apparatus **200** according to the embodiments of the present disclosure.
(13) (Chamber)
(14) As shown in FIGS. **1**, **2** and **3**, the substrate processing apparatus **200** mainly includes a chamber **302** which is a cylindrical airtight container (process container). A process chamber **301** configured to process a substrate **100** is formed in the chamber **302**. A gate valve **305** is connected to the chamber **302**, and the substrate **100** is loaded and unloaded via the gate valve **305**. The gate valve **305** is adjacent to a passage **305***a*. The substrate **100** is moved via the passage **305***a*.
(15) In the process chamber **301**, there are provided processing regions **306**, which are domains (regions) to which processing gases are supplied, and purge regions **307**, which are domains (regions) to which a purge gas is supplied. In the present disclosure, the processing regions **306** and the purge regions **307** are alternately arranged in a circumferential direction. For example, a first processing region **306***a* as a first domain, a first purge region **307***a* as a purge domain, a second processing region **306***b* as a second domain, and a second purge region **307***b* as a purge domain are arranged in the named order. As will be described later, a first gas is supplied into the first processing region **306***a*, a second gas is supplied into the second processing region **306***b*, and an inert gas is supplied into the first purge region **307***a* and the second purge region **307***b*. As a result, a predetermined process is performed on the substrate **100** according to the gas supplied into each region.
(16) The purge regions **307** are regions that spatially separate the first processing region **306***a* and the second processing region **306***b*. Ceilings **308** of the purge regions **307** are configured to be lower than ceilings **309** of the processing regions **306**. A ceiling **308***a* is installed at the first purge region **307***a*, and a ceiling **308***b* is installed at the second purge region **307***b*. By lowering each ceiling, a pressure in a space of the purge region **307** is increased. By supplying a purge gas to this space, the adjacent processing regions **306** are partitioned. Further, the purge gas removes an excess gas over the substrate **100**.
(17) In the chamber **302**, a substrate mounting plate **317** is installed as a support configured to support the substrate **100**. The substrate mounting plate **317** includes a rotation shaft arranged near the center of the chamber **302** and is configured to be rotatable. Further, the substrate mounting plate **317** is configured such that a plurality of (e.g., five) substrates **100** may be arranged on the

same plane and on the same circumference along a rotation direction. The substrate mounting plate **317** is heat-transmittable such that it may transmit heat radiating from a heater **380** described later. The transmitted heat is used to heat the substrate **100**. The substrate mounting plate **317** is made of, for example, quartz.

(18) A surface of the substrate mounting plate **317** includes substrate mounting surfaces **311** on which the substrates **100** are mounted and non-substrate-mounting surfaces **325** other than the substrate mounting surfaces **311**.

(19) The substrate mounting surfaces **311** are arranged at equal intervals (e.g., intervals of 72°) at positions concentric with the center of the substrate mounting plate **317**. In FIG. **1**, illustration of the substrate mounting surfaces **311** is omitted for convenience of explanation. The substrate mounting surfaces **311** are formed on bottom surfaces of recesses **312**. Each recess **312** is formed in, for example, a circular shape when viewed from the upper surface of the substrate mounting plate **317** and is formed in a concave shape when viewed from the side surface. A diameter of each of the recesses **312** is slightly larger than a diameter of the substrate **100**. By mounting the substrate **100** in each of the recesses **312**, the substrate **100** may be mounted on each of the substrate mounting surfaces **311**.

(20) The non-substrate-mounting surface **325** is a surface other than the substrate mounting surface **311** and is a surface on which the substrate **100** is not mounted. For example, the surface among the recesses **312**, the surface forming a region on the center side of the chamber **302** when viewed from the recesses **312**, the surface forming an outer peripheral region of the chamber **302** when viewed from the recesses **312**, and the like correspond to the non-substrate-mounting surface **325**.

(21) Each of the recesses **312** constituting the substrate mounting surfaces **311** is provided with a plurality of through-holes **317***a* through which lift pins **320** pass. A substrate holding mechanism **316** shown in FIG. **4** is installed below the substrate mounting plate **317** at a location facing the gate valve **305**. The substrate holding mechanism **316** includes a plurality of lift pins **320** that push up the substrate **100** and support the back surface of the substrate **100** when loading and unloading the substrate **100**. The lift pins **320** is configured to be stretchable and may be accommodated in, for example, a main body of the substrate holding mechanism **316**. When the substrate **100** is transferred, the lift pins **320** are stretched to hold the substrate **100**. Thereafter, tips of the lift pins **320** are moved downward such that the substrate **100** is mounted in the recess **312**. The substrate holding mechanism **316** may be formed in any configuration as long as the lift pins **320** may be inserted into the through-holes **317***a* when mounting the substrate.

(22) The substrate mounting plate **317** is fixed to a core portion **321**. The core portion **321** is provided at the center of the substrate mounting plate **317** to fix the substrate mounting plate **317**. A shaft **322** is arranged below the core portion **321**. The shaft **322** supports the core portion **321**.

(23) A lower portion of the shaft **322** penetrates the hole **323** formed at the bottom of the chamber **302** and is covered with an airtight bellows **304** outside the chamber **302**. Further, a rotator **319** is installed at the lower end of the shaft **322**. When the rotator **319** may also raise or lower the shaft **322**, it may be referred to as an elevating rotator. The rotator **319** is configured to be capable of rotating the substrate mounting plate **317** according to an instruction of a controller **400** described later.

(24) Below the substrate mounting plate **317**, a heater unit **381** including a heater **380** as a heating part (heater part) is arranged. The heater **380** heats each of the substrates **100** mounted on the substrate mounting plate **317**. The heater **380** is arranged in a circumferential direction in conformity with the shape of the chamber **302**. A heater controller **387** is connected to the heater **380**. The heater **380** is electrically connected to a controller **400** which will be described later. A power supplied to the heater **380** is controlled according to the instruction of the controller **400** to control the temperature.

(25) An exhaust buffer structure **386** is installed at the outer peripheral side of the substrate mounting plate **317** to extend along the outer periphery of the substrate mounting plate **317**. The

exhaust buffer structure **386** includes an exhaust groove **388** and an exhaust buffer space **389**. The exhaust groove **388** and the exhaust buffer space **389** are formed in a circumferential direction in conformity with the shape of the chamber **302**.
(26) Exhaust holes **392** are formed at the bottom of the exhaust buffer structure **386**. The exhaust holes **392** exhaust the gas supplied into the chamber **302**. Each gas is exhausted from the exhaust holes **392** via the exhaust groove **388** and the exhaust buffer space **389** that constitute the exhaust buffer structure **386**.
(27) Protrusions **390** are provided at portions of the exhaust buffer structure **386** adjacent to the purge regions **307**. The protrusions **390** are configured to extend from the outer periphery of the exhaust buffer structure **386** toward the substrate mounting plate **317**. By providing the protrusions **390**, the inert gas supplied from the purge regions **307** may be prevented from flowing in a large amount through the exhaust buffer structure **386**, which makes it possible to block the gas flowing from the upstream side.
(28) (Gas Supplier)
(29) Next, the gas supplier configured to supply gases to the chamber **302** will be described mainly with reference to FIGS. **1**, **2** and **5**A to **5**E. FIGS. **5**A to **5**E are explanatory diagrams illustrating configuration examples of a gas supplier in the substrate processing apparatus **200** according to the embodiments of the present disclosure.
(30) As shown in FIGS. **1** and **2**, a nozzle **341** extending to the first processing region **306***a*, a nozzle **342** extending to the second processing region **306***b*, a nozzle **344** extending to the first purge region **307***a*, a nozzle **345** extending to the second purge region **307***b*, a nozzle **346** extending to the exhaust buffer structure **386**, and a nozzle **348** extending onto the substrate mounting plate **317** in the process chamber **301** are installed at the chamber **302**, there are installed. “A” in FIG. **1** is connected to “A” in FIG. **5**A. That is, the nozzle **341** is connected to a supply pipe **241**. “B” in FIG. **1** is connected to “B” in FIG. **5**B. That is, the nozzle **342** is connected to a supply pipe **251**. “C” in FIG. **1** is connected to “C” in FIG. **5**C. That is, the nozzle **344** and the nozzle **345** are respectively connected to a supply pipe **261**. “D” in FIG. **2** is connected to “D” in FIG. **5**D. That is, the nozzle **346** is connected to a supply pipe **271**. “E” in FIG. **1** is connected to “E” in FIG. **5**E. That is, the nozzle **348** is connected to a supply pipe **281**.
(31) FIG. **5**A shows a configuration example of a first gas supplier **240**, which is included in the gas supplier. At the first gas supply pipe **241** of the first gas supplier **240**, a first gas supply source **242**, an MFC **243** as a flow rate controller (flow rate control part), and a valve **244** as an on-off valve are installed sequentially from the upstream side.
(32) A gas containing a first element (hereinafter referred to as “first gas”) is mainly supplied from the first gas supply pipe **241** of the first gas supplier **240**. That is, the first gas is supplied to the nozzle **341** via the MFC **243**, the valve **244** and the first gas supply pipe **241**. Then, the first gas is supplied to the first processing region **306***a* via the nozzle **341**.
(33) The first gas is a processing gas and is a precursor gas containing a first element. In the present disclosure, the first element is, for example, silicon (Si). That is, the first gas is a Si gas (also referred to as a Si-containing gas), which is a gas containing Si as a main component. Specifically, a dichlorosilane (DCS, SiH.sub.2Cl.sub.2) gas is used as the first gas.
(34) The first gas supplier **240** mainly includes the first gas supply pipe **241**, the MFC **243**, the valve **244** and the nozzle **341**. The first gas supply source **242** may be included in the first gas supplier **240**.
(35) FIG. **5**B shows a configuration example of a second gas supplier **250**, which is included in the gas supplier. At the second gas supply pipe **251** of the second gas supplier **250**, a second gas supply source **252**, an MFC **253** as a flow rate controller (flow rate control part), and a valve **254** are installed sequentially from the upstream side.
(36) A reaction gas (hereinafter referred to as “second gas”) that reacts with the first gas is mainly supplied from the second gas supply pipe **251** of the second gas supplier **250**. That is, the second

gas is supplied to the nozzle **342** via the MFC **253**, the valve **254** and the second gas supply pipe **251**. Then, the second gas is supplied to the second processing region **306***b* via the nozzle **342**.
(37) The second gas is a processing gas, for example, a nitrogen-containing gas containing nitrogen as a main component. As the nitrogen-containing gas, for example, an ammonia (NH_3) gas is used.
(38) The second gas supplier **250** mainly includes the second gas supply pipe **251**, the MFC **253**, the valve **254** and the nozzle **342**. The second gas supply source **252** may be included in the second gas supplier **250**. Since the second gas supplier **250** is configured to supply the reaction gas, it may be referred to as a reaction gas supplier.
(39) FIG. **5**C shows a configuration example of a purge gas (inert gas) supplier **260**, which is included in the gas supplier. At the purge gas supply pipe **261** of the purge gas supplier **260**, a purge gas supply source **262**, an MFC **263** as a flow rate controller (flow rate control part), and a valve **264** are installed sequentially from the upstream side.
(40) A purge gas (inert gas) is supplied from the purge gas supply pipe **261** of the purge gas supplier **260**. That is, the purge gas is supplied to each of the nozzle **344** and the nozzle **345** via the MFC **263**, the valve **264** and the purge gas supply pipe **261**. Then, the purge gas is supplied to the first purge region **307***a* via the nozzle **344** and is supplied to the second purge region **307***b* via the nozzle **345**.
(41) The purge gas is a gas that does not react with the first gas, the second gas, or the like. The purge gas is a gas that purges an atmosphere in the process chamber **301**, and is, for example, a nitrogen (N_2) gas.
(42) The purge gas supplier **260** mainly includes the purge gas supply pipe **261**, the MFC **263**, the valve **264**, the nozzle **344** and the nozzle **345**. The purge gas supply source **262** may be included in the purge gas supplier **260**.
(43) The first gas supplier **240** and the second gas supplier **250** are collectively referred to as a processing gas supplier. The purge gas supplier **260** may be included in the processing gas supplier.
(44) FIG. **5**D shows a configuration example of a third gas supplier **270**, which is included in the gas supplier. At the third gas supply pipe **271** of the third gas supplier **270**, a third gas supply source **272**, an MFC **273** as a flow rate controller (flow rate control part) and a valve **274** are installed sequentially from the upstream side.
(45) A cleaning gas is supplied from the third gas supply pipe **271** of the third gas supplier **270**. That is, the cleaning gas is supplied to the nozzle **346** via the MFC **273**, the valve **274** and the third gas supply pipe **271**. Then, the cleaning gas is supplied to the exhaust buffer structure **386** via the nozzle **346**.
(46) The cleaning gas is a gas to remove by-products produced by the reaction between the first gas and the second gas. For example, a trifluoride (NF_3) gas or a fluorine (F_2) gas is used as the cleaning gas.
(47) The third gas supplier **270** mainly includes the third gas supply pipe **271**, the MFC **273**, the valve **274** and the nozzle **346**. The third gas supply source **272** may be included in the third gas supplier **270**. Further, the third gas supplier **270** may include an activator (hereinafter also referred to as “first activator”) **275** configured to activate the cleaning gas. The details of the first activator **275** will be described later.
(48) FIG. **5**E shows a configuration example of a fourth gas supplier **280**, which is included in the gas supplier. At the fourth gas supply pipe **281** of the fourth gas supplier **280**, a fourth gas supply source **282**, an MFC **283** as a flow rate controller (flow rate control part) and a valve **284** are installed sequentially from the upstream side.
(49) A cleaning gas is supplied from the fourth gas supply pipe **281** of the fourth gas supplier **280**. That is, the cleaning gas is supplied to the nozzle **348** via the MFC **283**, the valve **284** and the fourth gas supply pipe **281**. Then, the cleaning gas is supplied onto the substrate mounting plate **317** in the process chamber **301** via the nozzle **348**.

(50) The cleaning gas is a gas to remove by-products produced by the reaction between the first gas and the second gas. For example, a NF.sub.3 gas or a F.sub.2 gas is used as the cleaning gas. However, the cleaning gas may contain components different from those of the cleaning gas supplied by the third gas supplier **270**.
(51) The fourth gas supplier **280** mainly includes the fourth gas supply pipe **281**, the MFC **283**, the valve **284** and the nozzle **348**. The fourth gas supply source **282** may be included in the fourth gas supplier **280**. Further, the fourth gas supplier **280** may include an activator (hereinafter also referred to as “second activator”) **285** configured to activate the cleaning gas. The details of the second activator **285** will be described later.
(52) As each of the first activator **275** and the second activator **285**, for example, a plasma generator, a heating catalyst, a second heater different from the heater **380**, or a microwave supplier may be used.
(53) (Gas Exhauster)
(54) Next, a gas exhauster configured to exhaust a gas from the chamber **302** will be described mainly with reference to FIGS. **1** and **2**.
(55) As shown in FIG. **1**, exhaust holes **392** are formed below the exhaust buffer structure **386** in the chamber **302**. The exhaust hoes **392** are formed at the respective processing regions **306**. Specifically, an exhaust hole **392***a* is formed to correspond to the first processing region **306***a*, and an exhaust hole **392***b* is formed to correspond to the second processing region **306***b*. That is, the exhaust hole **392***a* is arranged at the downstream side of the gas flow from the first gas supplier **240** configured to supply a gas to the first processing region **306***a*, and the exhaust hole **392***b* is arranged at the downstream side of the gas flow from the second gas supplier **250** configured to supply a gas to the second processing region **306***b*.
(56) A first gas exhauster **334**, which is included in the gas exhauster, is connected to the exhaust hole **392***a* arranged below the exhaust buffer structure **386** to correspond to the first processing region **306***a*. That is, the first exhaust pipe **334***a* included in the first gas exhauster **334** is connected to the chamber **302** to be in fluid communication with the exhaust hole **392***a*. A vacuum pump **334***b* as a vacuum-exhauster is connected to the first exhaust pipe **334***a* via a valve **334***d* as an on-off valve and an APC (Auto Pressure Controller) valve **334***c* as a pressure regulator (pressure regulation part). As a result, the first gas exhauster **334** is configured to be capable of vacuum-exhausting the inside of the process chamber **301** to a predetermined pressure (vacuum degree) via the exhaust buffer structure **386**.
(57) The first gas exhauster **334** mainly includes the APC valve **334***c*, the valve **334***d*, the first exhaust pipe **334***a* and the exhaust hole **392***a*. The vacuum pump **334***b* may be included in the first gas exhauster **334**.
(58) A second gas exhauster **335**, which is included in the gas exhauster, is connected to the exhaust hole **392***b* arranged below the exhaust buffer structure **386** to correspond to the second processing region **306***b*. That is, the second exhaust pipe **335***a* included in the second gas exhauster **335** is connected to the chamber **302** to be in fluid communication with the exhaust hole **392***b*. A vacuum pump **335***b* as a vacuum-exhauster is connected to the second exhaust pipe **335***a* via a valve **335***d* as an on-off valve and an APC valve **335***c* as a pressure regulator (pressure regulation part). As a result, the second gas exhauster **335** is configured to be capable of vacuum-exhausting the inside of the process chamber **301** to a predetermined pressure (vacuum degree) via the exhaust buffer structure **386**.
(59) The second gas exhauster **335** mainly includes the APC valve **335***c*, the valve **335***d*, the second exhaust pipe **335***a* and the exhaust hole **392***b*. The vacuum pump **335***b* may be included in the second gas exhauster **335**.
(60) (Controller)
(61) The substrate processing apparatus **200** configured as described above is controlled by a controller **400** as a control part (control unit or control means). Hereinafter, the controller **400** will

be described mainly with reference to FIG. **6**. FIG. **6** is a block diagram showing a functional configuration example of the controller **400** of the substrate processing apparatus **200** according to the embodiments of the present disclosure.

(62) The substrate processing apparatus **200** includes a controller **400** configured to control operations of the respective components such as the microwave supplier, the elevating rotator, the valves, the MFCs and the like. The controller **400** includes at least a calculator (CPU) **401**, a temporary memory **402**, a memory **403**, and a transmitter/receiver **404**. The controller **400** is connected to the respective components of the substrate processing apparatus **200** via the transmitter/receiver **404**. The controller **400** calls a program or a recipe from the memory **403** in response to an instruction from a host controller or a user and controls operations of the respective components according to contents of the program or the recipe. The controller **400** may be configured as a dedicated computer or a general-purpose computer. For example, the controller **400** according to the embodiments of the present disclosure may be configured by providing an external memory (e.g., a magnetic tape, a magnetic disc such as a flexible disc or a hard disc, an optical disc such as a CD or a DVD, a magneto-optical disc such as an MO or the like, and a semiconductor memory such as a USB memory (USB Flash Drive) or a memory card) **412** and installing a program on a general-purpose computer by using the external memory **412**. Further, a unit or means to supply the program to the computer is not limited to the case of supplying the program via the external memory **412**. For example, a communication unit or communication means such as the Internet or a dedicated line may be used. Information may be received from a host apparatus **420** via the transmitter/receiver **411** and the program may be supplied without going through the external memory **412**. In addition, an input/output device **413** such as a keyboard or a touch panel may be used to give an instruction to the controller **400**.

(63) The memory **402** or the external memory **412** is configured as a computer-readable recording medium. Hereinafter, the memory **402** and the external memory **412** are collectively and simply referred to as a recording medium. When the term “recording medium” is used herein, it may include a case of including the memory **402**, a case of including the external memory **412**, or a case of including both.

(2) Substrate Processing Process

(64) Next, a procedure in which a substrate processing process as a process of manufacturing a semiconductor device is performed by using the substrate processing apparatus **200** of the above-described configuration will be described. Description will be made on a case where in the substrate processing process, a silicon nitride (SiN) film is formed as a thin film on the substrate **100** by using a Si-containing gas as the first gas and using a NH.sub.3 gas as the second gas.

(65) Hereinafter, the substrate processing process will be described mainly with reference to FIG. **7**. FIG. **7** is a flowchart showing an example of a procedure of the substrate processing process executed by the substrate processing apparatus **200** according to the embodiments of the present disclosure. In the following description, operations of the respective components constituting the substrate processing apparatus **200** are controlled by the controller **400**.

(66) (Substrate Loading/Mounting Step)

(67) In the substrate processing process, first, a substrate loading/mounting step is performed. In FIG. **7**, the substrate loading/mounting step is not illustrated.

(68) In the substrate loading/mounting step, the substrate mounting plate **317** is rotated to move the recess **312** to a position adjacent to the gate valve **305**. Then, the lift pins **320** are raised to penetrate the through-holes **317***a* of the substrate mounting plate **317**. Subsequently, the gate valve **305** is opened to bring the chamber **302** into fluid communication with a vacuum transfer chamber (not shown). Then, the substrate **100** is transferred from this transfer chamber onto the lift pins **320** by using a wafer transfer machine (not shown). Thereafter, the lift pins **320** are lowered. As a result, the substrate **100** is supported on the substrate mounting surface **311**.

(69) After the substrate **100** is mounted on the substrate mounting surface **311**, the substrate

mounting plate **317** is rotated such that the substrate mounting surface **311** on which the substrate **100** is not mounted faces the gate valve **305**. Thereafter, the substrate is similarly mounted on the substrate mounting surface **311**. These are performed one or more times until the substrates **100** are mounted on the substrate mounting surfaces **311**.

(70) When the substrate **100** is mounted on the substrate mounting plate **317**, electric power is supplied to the heater **380** in advance to control the temperature of the surface of the substrate **100** to a predetermined temperature. The temperature of the substrate **100** is, for example, 400 degrees C. or higher and 500 degrees C. or lower. The heat radiating from the heater **380** is applied to the back surface of the substrate **100** via the substrate mounting plate **317**. The heater **380** is supplied with electric power at least from the substrate loading/mounting step to completion of a substrate unloading step described later.

(71) (Substrate Mounting Plate Rotation Start Step)

(72) After the substrates **100** are mounted in the respective recesses **312**, the substrate mounting plate rotation start step (S**110**) is performed. In the substrate mounting plate rotation start step (S**110**), the rotator **324** rotates the substrate mounting plate **317** in the R direction. By rotating the substrate mounting plate **317**, the substrate **100** moves through the first processing region **306***a*, the first purge region **307***a*, the second processing region **306***b* and the second purge region **307***b* in the named order.

(73) (Gas Supply Start Process)

(74) When the substrate **100** is heated to reach a desired temperature in the substrate loading/mounting process and the substrate mounting plate **317** reaches a desired rotation speed in the substrate mounting plate rotation start step (S**110**), then a gas supply start step (S**120**) is performed. In the gas supply start step (S**120**), the valve **244** is opened to start supplying a Si-containing gas into the first processing region **306***a*. At the same time, the valve **254** is opened to supply a NH.sub.3 gas into the second processing region **306***b*.

(75) At this time, the MFC **243** is regulated such that the flow rate of the Si-containing gas becomes a predetermined flow rate. The supply flow rate of the Si-containing gas is, for example, 50 sccm or more and 500 sccm or less.

(76) Further, the MFC **253** is regulated such that the flow rate of the NH.sub.3 gas becomes a predetermined flow rate. The supply flow rate of the NH.sub.3 gas is, for example, 100 sccm or more and 5000 sccm or less.

(77) After the substrate loading/mounting step is performed, the inside of the process chamber **301** is subsequently evacuated by the first gas exhauster **334** and the second gas exhauster **335**, and a N.sub.2 gas as a purge gas is supplied from the purge gas supplier **260** into the first purge region **307***a* and the second purge region **307***b*.

(78) (Film-Forming Step)

(79) Next, a film-forming step (S**130**) is performed. In the film-forming step (S**130**), a Si-containing layer is formed on each substrate **100** in the first processing region **306***a*, and the Si-containing layer reacts with the NH.sub.3 gas in the second processing region **306***b* after rotation, whereby a Si-containing film is formed on the substrate **100**. Then, the substrate mounting plate **317** is rotated a predetermined number of times such that a film thickness of the Si-containing film on the substrate **100** becomes a desired film thickness. At this time, the gases are also supplied to the non-substrate-mounting surface **325**. Therefore, a film may be formed on the non-substrate-mounting surface **325** as well.

(80) (Gas Supply Stop Step)

(81) After the substrate mounting plate **317** is rotated a predetermined number of times in the film-forming step (S**130**), a gas supply stop step (S**140**) is performed. In the gas supply stop step (S**140**), the valve **244** and the valve **254** are closed to stop the supply of the Si-containing gas to the first processing region **306***a* and the supply of the NH.sub.3 gas to the second processing region **306***b*.

(82) (Substrate Mounting Plate Rotation Stop Step)

(83) After the gas supply stop step (S**140**), a substrate mounting plate rotation stop step (S**150**) is performed. In the substrate mounting plate rotation stop step (S**150**), the rotation of the substrate mounting plate **317** is stopped.
(84) (Substrate Unloading Step)
(85) After the substrate mounting plate rotation stop step (S**150**), a substrate unloading step is performed. In FIG. **7**, the substrate unloading step is not illustrated.
(86) In the substrate unloading step, the substrate mounting plate **317** is rotated to move the substrate **100** to be unloaded to a position adjacent to the gate valve **305**. Thereafter, the substrate **100** is unloaded in the reverse procedure to that of the substrate loading procedure. These operations are performed one or more times to unload all the substrates **100**.
(3) Cleaning Process
(87) As described above, in the substrate processing process, the Si-containing gas and the NH.sub.3 gas are supplied to the substrate **100** in the process chamber **301** to form the SiN layer on the substrate **100**. At that time, the gases are also supplied to the non-substrate-mounting surface **325** of the substrate mounting plate **317**. Therefore, a film may also be formed on the non-substrate-mounting surface **325** by mixing of the Si-containing gas and the NH.sub.3 gas. Further, the gases supplied into the process chamber **301** are exhausted by the first gas exhauster **334** and the second gas exhauster **335**. At that time, the gases are moved via the exhaust buffer structure **386**. Therefore, a film may also be formed on an inner wall of the exhaust buffer structure **386**.
(88) Since these films are films that are formed unintentionally, that is, films whose qualities are not controlled, a cleaning process may be performed to remove the films.
(89) Hereinafter, the cleaning process executed by the substrate processing apparatus **200** according to the embodiments of the present disclosure will be described. In the following description, operations of the respective components constituting the substrate processing apparatus **200** are controlled by the controller **400**.
(90) (Cleaning Process of Exhaust Buffer Structure)
(91) The exhaust buffer structure **386** may be subjected to a regular cleaning process because the Si-containing gas, which is the first gas, and the NH.sub.3 gas, which is the second gas, may be mixed in the process of exhausting the gases supplied into the process chamber **301**. Specifically, in the substrate processing process, the temperature is regulated in the process chamber **301** such that a quality-controlled film (hereinafter also referred to as “controlled film”) is formed on the substrate **100**. On the other hand, the temperature is not regulated in the exhaust buffer structure **386**. Therefore, the temperature in the exhaust buffer structure **386** may different from that of the process chamber **301**, for example, the temperature in the exhaust buffer structure **386** may be lower than that of the process chamber **301**. Thus, an unintended film, that is, a film whose quality is not controlled (hereinafter also referred to as “uncontrolled film”) may be formed. Since the uncontrolled film in the exhaust buffer structure **386** is formed under a temperature condition which is lower than a temperature condition under which the controlled film is formed, the uncontrolled film may be peeled off easily to become particles.
(92) Therefore, the substrate processing apparatus **200** according to the embodiments of the present disclosure includes a third gas supplier **270** to reliably remove the uncontrolled film formed on the exhaust buffer structure **386**. The third gas supplier **270** directly supplies a cleaning gas to the inside of the exhaust buffer structure **386**. As a result, even when the gas exhausted from the process chamber **301** is moved via the exhaust buffer structure **386**, it is possible to improve an efficiency of the cleaning process performed on the exhaust buffer structure **386**. That is, the uncontrolled film formed on the exhaust buffer structure **386** may be efficiently and reliably removed by directly supplying the cleaning gas.
(93) At this time, when the third gas supplier **270** includes the first activator **275**, the cleaning gas supplied by the third gas supplier **270** may be activated by using the first activator **275**. As the first activator **275**, for example, any one of a plasma generator, a heating catalyst, a second heater

different from the heater **380**, and a microwave supplier may be used.

(94) When the cleaning gas is activated by using such a first activator **275**, even when the cleaning gas is supplied to the exhaust buffer structure **386** including no component (for example, a heater) configured to add energy, it is possible to add energy to the cleaning gas, which may further improve the efficiency of the cleaning process performed on the exhaust buffer structure **386**.

(95) The cleaning gas may be supplied to the exhaust buffer structure **386** as follows. For example, the third gas supplier **270** may be configured to be capable of supplying, as the cleaning gas, a first cleaning gas capable of removing a carbon-containing film and a second cleaning gas capable of removing a carbon-free film to the exhaust buffer structure **386**. When supplying the cleaning gas to the exhaust buffer structure **386**, the controller **400** controls the third gas supplier **270** to first supply the first cleaning gas and then supply the second cleaning gas. As the first cleaning gas, for example, an oxygen-based O.sub.3 gas, a NO gas, or the like may be used. As the second cleaning gas, for example, a NF.sub.3 gas may be used.

(96) The cleaning gas may be supplied in this way, specifically when a gas containing carbon is used as the processing gas. An adsorption rate of carbon to the wall surface is higher than those of other components such as Si or the like. Therefore, the carbon may not be completely removed by normal cleaning, and a carbon-containing film containing carbon may remain easily. Thus, the first cleaning gas capable of removing a carbon-containing film is first supplied to vaporize a carbon component, and then the second cleaning gas capable of removing a carbon-free film is supplied to remove the entire film. That is, by supplying the first cleaning gas and the second cleaning gas, it is possible to efficiently and reliably remove the carbon-containing film.

(97) (Cleaning Process of Non-Substrate-Mounting Surface)

(98) The uncontrolled film may be formed on the non-substrate-mounting surface **325** of the substrate mounting plate **317**, as well as on the exhaust buffer structure **386**.

(99) Therefore, the substrate processing apparatus **200** according to the embodiments of the present disclosure includes a fourth gas supplier **280** to reliably remove the uncontrolled film formed on the non-substrate-mounting surface **325**. Then, the fourth gas supplier **280** supplies a cleaning gas onto the substrate mounting plate **317** in the process chamber **301**. Thus, the uncontrolled film formed on the non-substrate-mounting surface **325** may be removed by supplying the cleaning gas onto the substrate mounting plate **317**. The substrate mounting plate **317** is rotated while supplying the cleaning gas.

(100) At this time, since the heater **380** is arranged below the substrate mounting plate **317**, the heater **380** is used to heat the substrate mounting plate **317**. By doing so, the cleaning process may be performed with the substrate mounting plate **317** kept in a heated state. Therefore, the efficiency of the cleaning process performed on the non-substrate-mounting surface **325** of the substrate mounting plate **317** becomes higher than that when the cleaning process is performed without heating.

(101) The fourth gas supplier **280**, which performs a cleaning process on the non-substrate-mounting surface **325**, is installed higher than the third gas supplier **270**, which performs a cleaning process on the exhaust buffer structure **386**, in the direction in which gravity acts (hereinafter referred to as “gravity direction”). More specifically, the nozzle **348** constituting the fourth gas supplier **280** is installed higher than the nozzle **346** constituting the third gas supplier **270** in the vertical direction when the substrate processing apparatus **200** is installed. By arranging the nozzle **348** of the fourth gas supplier **280** on the upper side, the cleaning gas from the nozzle **348** may be supplied to the entire region on the substrate mounting plate **317**, which makes it possible to efficiently perform the cleaning process on the non-substrate-mounting surface **325**. Further, by arranging the nozzle **346** of the third gas supplier **270** on the lower side, the cleaning gas may be directly supplied to the exhaust buffer structure **386** which is a gas exhaust path from the inside of the chamber **302**. This makes it possible to efficiently perform the cleaning process on the exhaust buffer structure **386**.

(102) (Relationship among Respective Cleaning Processes)
(103) Now, the relationship between the cleaning process performed by the third gas supplier **270** and the cleaning process performed by the fourth gas supplier **280** will be described. As described above, both the cleaning gas supply from the third gas supplier **270** and the cleaning gas supply from the fourth gas supplier **280** are controlled by the controller **400**.
(104) For example, the controller **400** controls the third gas supplier **270** and the fourth gas supplier **280** such that, for example, the cleaning gas is supplied from the third gas supplier **270** to the exhaust buffer structure **386** while operating the first activator **275**, and the cleaning gas is supplied from the fourth gas supplier **280** onto the substrate mounting plate **317** while operating the heater **380**. When the respective cleaning processes are performed in this way, it is possible to perform the cleaning process on the substrate mounting plate **317** while heating the substrate mounting plate **317** with the heater **380**. On the other hand, the exhaust buffer structure **386** is not easily affected by the heating performed by the heater **380**. Instead, the first activator **275** may be used to increase the energy of the cleaning gas. Therefore, the cleaning process may be efficiently performed on both the non-substrate-mounting surface **325** of the substrate mounting plate **317** and the exhaust buffer structure **386**.
(105) Further, the controller **400** controls the third gas supplier **270** and the fourth gas supplier **280** such that, for example, a partial pressure of the cleaning gas when the third gas supplier **270** cleans the exhaust buffer structure **386** is higher than a partial pressure of the cleaning gas when the fourth gas supplier **280** performs the cleaning process on the substrate mounting plate **317**. When the pressure of the cleaning gas in the exhaust buffer structure **386** is increased in this way, the cleaning gas is brought into contact with the uncontrolled film formed in the exhaust buffer structure **386** in a high-pressure state. Therefore, even when the exhaust buffer structure **386** does not include a heater, it is possible to improve the efficiency of the cleaning process performed on the exhaust buffer structure **386**.
(106) Further, the controller **400** controls the third gas supplier **270** and the fourth gas supplier **280** such that, for example, a frequency of the cleaning process performed on the exhaust buffer structure **386** performed by the third gas supplier **270** is higher than a frequency of the cleaning process performed on the substrate mounting plate **317** performed by the fourth gas supplier **280**. On the substrate mounting plate **317**, a film-forming condition such as a temperature is determined in the same manner as the substrate **100**, whereby a film of high adhesion strength may be formed on the substrate mounting plate **317**. On the other hand, the film-forming condition such as the temperature is determined on the exhaust buffer structure **386**. Therefore, a film of weak adhesion strength may be formed on the exhaust buffer structure **386**. That is, particles may be generated more frequently in the exhaust buffer structure **386** than on the substrate mounting plate **317**. Therefore, in a case where the respective cleaning processes are performed at the same frequency, the substrate mounting plate **317** may be further cleaned in a state that the cleaning process is completed, which may cause over-etching. Accordingly, by increasing the frequency of the cleaning process performed on the exhaust buffer structure **386**, it is possible to eliminate a risk of over-etching and to improve the efficiency of the respective cleaning processes.
(107) Further, the controller **400** controls the third gas supplier **270** and the fourth gas supplier **280** such that, for example, a supply time of the cleaning gas supplied by the third gas supplier **270** to the exhaust buffer structure **386** is longer than a supply time of the cleaning gas supplied by the fourth gas supplier **280** onto the substrate mounting plate **317**. In a case where the supply times of the cleaning gases in the respective cleaning processes are the same, over-etching may occur on the substrate mounting plate **317**. Therefore, by increasing the supply time of the cleaning gas to the exhaust buffer structure **386**, it is possible to eliminate the risk of over-etching and to improve the efficiency of the respective cleaning processes.
(108) Further, when the adhesion strength of the uncontrolled film formed on the substrate mounting plate **317** is stronger than that of the uncontrolled film formed in the exhaust buffer

structure **386**, the controller **400** may control the third gas supplier **270** and the fourth gas supplier **280** such that, for example, the supply time of the cleaning gas supplied by the fourth gas supplier **280** onto the substrate mounting plate **317** is longer than the supply time of the cleaning gas supplied by the third gas supplier **270** to the exhaust buffer structure **386**. In a case where the supply times of the cleaning gases in the respective cleaning processes are the same, over-etching may occur on the exhaust buffer structure **386**. Therefore, by increasing the supply time of the cleaning gas to the substrate mounting plate **317**, it is possible to eliminate the risk of over-etching and to improve the efficiency of the respective cleaning processes.

(109) Further, the controller **400** controls the third gas supplier **270** and the fourth gas supplier **280** such that, for example, the supply of the cleaning gas onto the substrate mounting plate **317** by the fourth gas supplier **280** is stopped and the supply of the cleaning gas to the exhaust buffer structure **386** by the third gas supplier **270** is started after a predetermined time has elapsed from the supply of the cleaning gas onto the substrate mounting plate **317** by the fourth gas supplier **280**. That is, after the non-substrate-mounting surface **325** of the substrate mounting plate **317** is cleaned, the exhaust buffer structure **386** is cleaned. In a case where the cleaning process is performed in the reverse order, foreign substances (by-products after removal, and the like.) generated in the cleaning process performed on the non-substrate-mounting surface **325** may adhere to the exhaust buffer structure **386**. In this case, in a case where the cleaning process is performed on the exhaust buffer structure **386** after the cleaning process is performed on the non-substrate-mounting surface **325**, it is possible to prevent foreign substances from adhering to the inside of the exhaust buffer structure **386** and to improve the efficiency of the respective cleaning processes.

(110) Further, the controller **400** may control the third gas supplier **270** and the fourth gas supplier **280** such that, for example, the number of times the cleaning gas is supplied by the third gas supplier **270** to the exhaust buffer structure **386** is larger than the number of times the cleaning gas is supplied by the fourth gas supplier **280** onto the substrate mounting plate **317**. In a case where the number of times the cleaning gas is supplied in the respective cleaning processes are the same, over-etching may occur on the substrate mounting plate **317** as in the case of the frequency described above. Therefore, by increasing the number of times the cleaning gas is supplied to the exhaust buffer structure **386**, it is possible to eliminate the risk of over-etching and to improve the efficiency of the respective cleaning processes.

(111) Further, in a case where a adhesion strength of the uncontrolled film on the substrate mounting plate **317** is stronger than that of the uncontrolled film in the exhaust buffer structure **386**, the controller **400** may control the third gas supplier **270** and the fourth gas supplier **280** such that, for example, the number of times the cleaning gas is supplied by the fourth gas supplier **280** onto the substrate mounting plate **317** is larger than the number of times the cleaning gas is supplied by the third gas supplier **270** to the exhaust buffer structure **386**. In a case where the number of times the cleaning gas is supplied in the respective cleaning processes are the same, over-etching may occur on the exhaust buffer structure **386**. Therefore, by increasing the number of times the cleaning gas is supplied to the substrate mounting plate **317**, it is possible to eliminate the risk of over-etching and to improve the efficiency of the respective cleaning processes.

(112) Further, in a case where the fourth gas supplier **280** includes the second activator **285**, the controller **400** may use the second activator **285** to activate the cleaning gas supplied by the fourth gas supplier **280**. In the same manner as the first activator **275** of the third gas supplier **270**, the second activator **285** may use, for example, any one of a plasma generator, a heating catalyst, a second heater different from the heater **380** and a microwave supplier. In such a case, the controller **400** controls the first activator **275** of the third gas supplier **270** and the second activator **285** of the fourth gas supplier **280** such that, for example, an amount of activation energy of the first activator **275** with respect to the cleaning gas supplied by the third gas supplier **270** is larger than an amount of activation energy of the second activator **285** with respect to the cleaning gas supplied by the fourth gas supplier **280**. By doing so, it is possible to eliminate the risk of over-etching on the

substrate mounting plate **317** while improving the efficiency of the cleaning process by activating the cleaning gas.

(113) Further, in a case where the adhesion strength of the uncontrolled film formed on the substrate mounting plate **317** is stronger than that of the uncontrolled film formed in the exhaust buffer structure **386**, the controller **400** controls the first activator **275** of the third gas supplier **270** and the second activator **285** of the fourth gas supplier **280** such that, for example, an amount of activation energy of the second activator **285** with respect to the cleaning gas supplied by the fourth gas supplier **280** is larger than an amount of activation energy of the first activator **275** with respect to the cleaning gas supplied by the third gas supplier **270**. By doing so, it is possible to eliminate the risk of over-etching in the exhaust buffer structure **386** while improving the efficiency of the cleaning process by activating the cleaning gas.

(114) The cleaning gas supplied from the third gas supplier **270** and the cleaning gas supplied from the fourth gas supplier **280** may be different in component from each other. In such a case, the respective cleaning gases are provided such that the by-product removal action (removal energy) by the cleaning gas supplied from the third gas supplier **270** is stronger than the by-product removal action (removal energy) by the cleaning gas supplied from the fourth gas supplier **280**. By doing so, it is possible to eliminate the risk of over-etching on the substrate mounting plate **317** without making supply conditions of the respective cleaning gases different.

(115) (Relationship with Purge Gas Supplier)

(116) Next, a relationship between each of the cleaning processes by the third gas supplier **270** and the fourth gas supplier **280** and the purge gas supply by the purge gas supplier **260** will be described. As described above, the purge gas is supplied from the purge gas supplier **260** into the chamber **302**. The purge gas supply from the purge gas supplier **260** is controlled by the controller **400**.

(117) The controller **400** controls the purge gas supplier **260** and the third gas supplier **270** such that, for example, the purge gas is supplied from the purge gas supplier **260** in parallel with the cleaning gas supply to the exhaust buffer structure **386** by the third gas supplier **270**. Thus, when the exhaust buffer structure **386** is cleaned, the pressure in the process chamber **301** may be made higher than that in the exhaust buffer structure **386** by supplying the purge gas, whereby foreign substances (by-products after removal, and the like) generated when the exhaust buffer structure **386** is cleaned may be prevented from moving toward the process chamber **301**. That is, even though the process chamber **301** and the exhaust buffer structure **386** are in fluid communication with each other, it is possible to appropriately perform the cleaning process on the exhaust buffer structure **386**.

(118) At this time, the controller **400** controls the purge gas supplier **260** and the third gas supplier **270** such that, for example, while supplying the cleaning gas from the third gas supplier **270** to the exhaust buffer structure **386**, a partial pressure above the substrate mounting plate **317** is higher than a partial pressure in the exhaust buffer structure **386**. By doing so, a pressure difference is generated between the upper side of the substrate mounting plate **317** and the exhaust buffer structure **386**, whereby foreign substances may be reliably prevented from moving from the exhaust buffer structure **386** into the process chamber **301**.

(119) Specifically, the substrate mounting plate **317** is provided with the through-holes **317***a* through which the lift pins **320** supporting the substrate **100** pass. The controller **400** is configured to control the purge gas supplier **260** and the third gas supplier **270** such that, while supplying the cleaning gas from the third gas supplier **270** to the exhaust buffer structure **386**, the partial pressure above the through-holes **317***a* is higher than the partial pressure in the exhaust buffer structure **386**. By doing so, the partial pressure above the through-holes **317***a* may be increased. Therefore, even when the lift pins **320** pass through the through-holes **317***a*, the cleaning gas supplied to the exhaust buffer structure **386** and the foreign substances or the like removed by the cleaning gas do not swirl upward to the upper side of the substrate mounting plate **317** via the through-holes **317***a*.

(120) (Nozzle Arrangement of Third Gas Supplier)
(121) Next, a nozzle arrangement of the third gas supplier **270** controlled as described above will be described.
(122) The nozzle **346** of the third gas supplier **270** may be arranged between the nozzle **341** of the first gas supplier **240** or the nozzle **342** of the second gas supplier **250** and the exhaust holes **392** (**392***a* and **392***b*) installed below the exhaust buffer structure **386** in the gravity direction (vertical direction). Further, the nozzle **346** of the third gas supplier **270** may be arranged between the nozzle **341** of the first gas supplier **240** and the nozzle **342** of the second gas supplier **250** in the direction (horizontal direction) orthogonal to the gravity direction.
(123) Further, the nozzle **346** of the third gas supplier **270** may be installed on the downstream side of the gas flow in the first purge region **307***a* and the second purge region **307***b* set between the first processing region **306***a* and the second processing region **306***b*.
(124) Further, the nozzle **346** of the third gas supplier **270** may be installed below the protrusion **390**.
(125) Further, the chamber **302** includes a gate valve **305** that may be opened and closed, and a passage **305***a* formed between the gate valve **305** and the substrate mounting plate **317**. The nozzle **346** of the third gas supplier **270** may be configured to be capable of supplying the cleaning gas to the passage **305***a* in the chamber **302** as well.
(126) At each of these components, the mixing of the first gas (Si-containing gas, and the like) and the second gas (NH.sub.3 gas and the like) is likely to occur and the foreign substances (by-products, and the like) to be removed in the cleaning process are likely to be accumulated. Specifically, on the downstream side of the first purge region **307***a* and the second purge region **307***b* as the purge domain, the gas just passed below the ceiling **308** or through a space between the protrusion **390** and the substrate mounting plate **317** or the ceiling **308**, and the pressure on the gas may fluctuate to cause turbulent flow of the gas may occur. Thus, foreign substances are more likely to be accumulated than in other places. Further, since the space between the protrusion **390** and the substrate mounting plate **317** is narrow and the pressure is high in the space, foreign substances tend to be accumulated between the protrusion **390** and the substrate mounting plate **317**. Further, in the vicinity of the gate valve **305**, the gas collides with the wall constituting the passage **305***a* or the pressure on the gas fluctuates to generate the turbulent flow. Therefore, foreign substances tend to be accumulated in the passage **305***a*.
(127) Even in that case, by arranging the nozzles described above, the third gas supplier **270** may supply fresh (non-deactivated) cleaning gas to each portion where foreign substances are likely to be accumulated. This makes it possible to improve the cleaning efficiency for each portion.
(128) (Relationship between Third Gas Supplier and Gas Exhauster)
(129) Next, a relationship between the third gas supplier **270** and the first gas exhauster **334** and the second gas exhauster **335** as the gas exhauster will be described. The gas exhaust from the chamber **302** by the first gas exhauster **334** and the second gas exhauster **335** is controlled by the controller **400**.
(130) The controller **400** controls the first gas exhauster **334**, the second gas exhauster **335** and the third gas supplier **270** such that, for example, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the stop of exhaust by the first gas exhauster **334**, and the execution of exhaust by the second gas exhauster **335** are performed in parallel, or the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the execution of exhaust by the first gas exhauster **334**, and the stop of exhaust by the second gas exhauster **335** are performed in parallel. In a case where the gas flow generated by an exhaust system of the first gas exhauster **334** or the second gas exhauster **335** is stopped in this way during the cleaning process on the exhaust buffer structure **386**, the cleaning gas reaches the entire exhaust buffer structure **386**. Therefore, the entire exhaust buffer structure **386** may be cleaned without omission.
(131) Further, the controller **400** controls the first gas exhauster **334**, the second gas exhauster **335**,

and the third gas supplier **270** such that, for example, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, and the exhaust control by which the amount of exhaust by the first gas exhauster **334** becomes larger than the amount of exhaust by the second gas exhauster **335** are performed in parallel or such that the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, and the exhaust control by which the amount of exhaust by the first gas exhauster **334** becomes smaller than the amount of exhaust by the second gas exhauster **335** are performed in parallel. In a case where the volume of exhaust by an exhaust system of the first gas exhauster **334** or the second gas exhauster **335** is made small in this way during the cleaning process performed on the exhaust buffer structure **386**, even when the gas flow generated by the exhaust system is not completely stopped, the cleaning gas tends to reach the entire exhaust buffer structure **386**. Therefore, the entire exhaust buffer structure **386** may be cleaned without omission.

(132) Further, the controller **400** controls the first gas exhauster **334**, the second gas exhauster **335** and the third gas supplier **270** such that, for example, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the stop of exhaust performed by the first gas exhauster **334**, and the stop of exhaust performed by the second gas exhauster **335** are performed in parallel. In a case where the gas flows generated by the first gas exhauster **334** and the second gas exhauster **335** are stopped in this way during the cleaning process performed on the exhaust buffer structure **386**, the cleaning gas may be confined in the exhaust buffer structure **386**. This may be used in improving the efficiency of the cleaning process performed on the exhaust buffer structure **386**.

(133) Specifically, the confining of the cleaning gas in the exhaust buffer structure **386** may be used when a portion where the cleaning gas is difficult to enter, for example, the protrusion **390** of the exhaust buffer structure **386** is installed in the exhaust buffer structure **386**. That is, in a case where a distance between the outer peripheral wall constituting the exhaust buffer structure **386** and the substrate mounting plate **317** is set such that the distance in the purge regions **307***a* and **307***b* is smaller than the distance in the first processing region **306***a* and the second processing region **306***b* as much as the protrusion **390** is installed, the cleaning gas may be confined in the exhaust buffer structure **386**, which may improve the efficiency of the cleaning process performed on the exhaust buffer structure **386**.

(4) Effects of the Embodiments

(134) According to the embodiments of the present disclosure, one or more of the following effects may be obtained. (a) According to the embodiments of the present disclosure, the third gas supplier **270** directly supplies the cleaning gas to the exhaust buffer structure **386**. Therefore, in a case where the gas supplied into the chamber **302** is exhausted, even when the mixing of the first gas (Si-containing gas, and the like) and the second gas (NH.sub.3 gas, and the like) may occur and the uncontrolled film may be formed in the exhaust buffer structure **386** serving as an exhaust path, it is possible to improve the efficiency of the cleaning process performed on the exhaust buffer structure **386**. That is, by improving the cleaning efficiency of the exhaust system, it is possible to efficiently and reliably remove the uncontrolled film formed in the exhaust buffer structure **386**. (b) According to the embodiments of the present disclosure, the first activator **275** activates the cleaning gas supplied by the third gas supplier **270**. Therefore, even when the cleaning gas is supplied to the exhaust buffer structure **386** including no configuration (for example, a heater) to add energy, it is possible to add energy to the cleaning gas and to further improve the efficiency of the cleaning process. (c) According to the embodiments of the present disclosure, when the cleaning gas is supplied to the exhaust buffer structure **386**, the first cleaning gas capable of removing a carbon-containing film is first supplied, and then the second cleaning gas capable of removing a carbon-free film is supplied, which may be used when a gas containing carbon is used as the processing gas, such that it is possible to remove the carbon-containing film efficiently and reliably. (d) According to the embodiments of the present disclosure, the fourth gas supplier **280**

supplies the cleaning gas onto the substrate mounting plate **317** in the process chamber **301**. At that time, the heater **380** heats the substrate mounting plate **317**. Therefore, the cleaning process may be performed with the substrate mounting plate **317** kept in a heated state. Therefore, the efficiency of the cleaning performed on the non-substrate-mounting surface **325** of the substrate mounting plate **317** may be improved as compared with the case where heating is not performed. (e) According to the embodiments of the present disclosure, the fourth gas supplier **280** is installed above the third gas supplier **270** in the gravity direction. Therefore, the cleaning gas from the fourth gas supplier **280** on the upper side may be supplied to the entire region on the substrate mounting plate **317**, and therefore the cleaning process performed on the non-substrate-mounting surface **325** may be efficiently performed. Moreover, by arranging the third gas supplier **270** on the lower side, the cleaning gas may be directly supplied to the exhaust buffer structure **386** which is a gas exhaust path from the inside of the chamber **302**, and the cleaning process may be efficiently performed on the exhaust buffer structure **386**. (f) According to the embodiments of the present disclosure, the cleaning gas is supplied from the third gas supplier **270** to the exhaust buffer structure **386** while operating the first activator **275**, and the cleaning gas is supplied from the fourth gas supplier **280** onto the substrate mounting plate **317** while operating the heater **380**. Therefore, the cleaning process may be efficiently performed on both the non-substrate-mounting surface **325** of the substrate mounting plate **317** and the exhaust buffer structure **386**. (g) According to the embodiments of the present disclosure, the first activator **275** installed at the third gas supplier **270** is any one of a plasma generator, a heating catalyst, a second heater, and a microwave supplier. Therefore, the cleaning gas supplied by the third gas supplier **270** may be reliably activated, whereby the cleaning process may be performed on the exhaust buffer structure **386** efficiently. (h) According to the embodiments of the present disclosure, the partial pressure of the cleaning gas when the third gas supplier **270** cleans the exhaust buffer structure **386** is set to be higher than the partial pressure of the cleaning gas when the fourth gas supplier **280** cleans the substrate mounting plate **317**. Therefore, even when the exhaust buffer structure **386** does not include a heater, the efficiency of the cleaning process performed on the exhaust buffer structure **386** may be improved. (i) According to the embodiments of the present disclosure, the frequency of the cleaning process performed on the exhaust buffer structure **386** performed by the third gas supplier **270** is set to be higher than the frequency of the cleaning process performed on the substrate mounting plate **317** performed by the fourth gas supplier **280**. Therefore, when the cleaning processes are performed at the same frequency, the substrate mounting plate **317** may be over-etched. However, according to the embodiments of the present disclosure, it is possible to eliminate the risk of such over-etching and to improve the efficiency of each cleaning process. (j) According to the embodiments of the present disclosure, the supply time of the cleaning gas supplied by the third gas supplier **270** to the exhaust buffer structure **386** is set to be longer than the supply time of the cleaning gas supplied by the fourth gas supplier **280** onto the substrate mounting plate **317**. Therefore, when the supply times of the cleaning gas in the respective cleaning processes are the same, the substrate mounting plate **317** may be over-etched. However, according to the embodiments of the present disclosure, it is possible to eliminate the risk of such over-etching and to improve the efficiency of each cleaning process. (k) According to the embodiments of the present disclosure, after a predetermined time has elapsed from the supply of the cleaning gas onto the substrate mounting plate **317** by the fourth gas supplier **280**, the supply of the cleaning gas onto the substrate mounting plate **317** is stopped and the supply of the cleaning gas to the exhaust buffer structure **386** by the third gas supplier **270** is started. Therefore, there is no possibility that foreign substances (by-products after removal, etc.) generated in the cleaning process performed on the non-substrate-mounting surface **325** adheres to the exhaust buffer structure **386**. Thus, it is possible to prevent foreign substances from adhering to the inside of the exhaust buffer structure **386**, which may improve the efficiency of each cleaning process. (l) According to the embodiments of the present disclosure, the number of times the cleaning gas is supplied by the third gas supplier **270** to the exhaust buffer structure **386** is set to be higher than the number of times the cleaning gas is supplied by the fourth gas supplier **280** onto the substrate mounting plate **317**. Therefore, when the number of times the cleaning gas is supplied in the respective cleaning processes is the same, the substrate mounting plate **317** may be over-etched. However, according to the embodiments of the present disclosure, it is possible to eliminate the risk of such over-etching and to improve the efficiency of each cleaning process. (m) According to the embodiments of the present disclosure, the amount of activation energy of the first activator **275** with respect to the cleaning gas supplied by the third gas supplier **270** is set to be larger than the amount of activation energy of the second activator **285** with respect to the cleaning gas supplied by the fourth gas supplier **280**. Therefore, it is possible to eliminate the risk of over-etching on the substrate mounting plate **317** while improving the efficiency of the cleaning process by activating the cleaning gas. (n) According to the embodiments of the present disclosure, the components of the cleaning gas supplied from the third gas supplier **270** and the components of the cleaning gas supplied from the fourth gas supplier **280** are different from each other. Specifically, the respective cleaning gases are provided such that, for example, the by-product removal action (removal energy) by the cleaning gas supplied from the third gas supplier **270** is stronger than the by-product removal action (removal energy) by the cleaning gas supplied from the fourth gas supplier **280**. Therefore, it is possible to eliminate the risk of over-etching on the substrate mounting plate **317** without making supply conditions of the respective cleaning gases different. (o) According to the embodiments of the present disclosure, the purge gas is supplied from the purge gas supplier **260** in parallel with the cleaning gas supply to the exhaust buffer structure **386** by the third gas supplier **270**. Therefore, in the cleaning process performed on the exhaust buffer structure **386**, the pressure in the process chamber **301** may be made higher than that in the exhaust buffer structure **386** by supplying the purge gas. Therefore, it is possible to prevent the foreign substances generated in the cleaning process performed on the exhaust buffer structure **386** from moving toward the process chamber **301**. That is, even when the process chamber **301** and the exhaust buffer structure **386** are in fluid communication with each other, the cleaning process performed on the exhaust buffer structure **386** may be appropriately performed. (p) According to the embodiments of the present disclosure, the purge gas is supplied from the purge gas supplier **260** such that while the third gas supplier **270** supplies the cleaning gas to the exhaust buffer structure **386**, the partial pressure on the upper side of the substrate mounting plate **317** is higher than the partial pressure in the exhaust buffer structure **386**. Therefore, since a pressure difference is generated between the upper side of the substrate mounting plate **317** and the exhaust buffer structure **386**, it is possible to reliably suppress the movement of foreign substances from the exhaust buffer structure **386** into the process chamber **301**. (q) According to the embodiments of the present disclosure, the purge gas is supplied from the purge gas supplier **260** such that while the third gas supplier **270** supplies the cleaning gas to the exhaust buffer structure **386**, the partial pressure on the upper side of the through-holes **317***a* is higher than the partial pressure in the exhaust buffer structure **386**. This makes it possible to increase the partial pressure on the upper side of the through-holes **317***a*. Therefore, even when the lift pins **320** pass through the through-holes **317***a*, the cleaning gas supplied to the exhaust buffer structure **386** and the foreign substances removed by the cleaning gas do not swirl up to the upper side of the substrate mounting plate **317** via the through-holes **317***a*. (r) According to the embodiments of the present disclosure, the third gas supplier **270** is arranged between the first gas supplier **240** or the second gas supplier **250** and the exhaust holes **392** (**392***a* and **392***b*) installed below the exhaust buffer structure **386** in the gravity direction. Further, the third gas supplier **270** is arranged between the first gas supplier **240** and the second gas supplier **250** in the direction orthogonal to the gravity direction. Further, according to the embodiments of the present disclosure, the third gas supplier **270** is installed on the downstream side of the gas flow in the first purge region **307***a* and the second purge region **307***b* set between the first processing region **306***a* and the second processing region **306***b*. Further, according to the embodiments of the present disclosure, the third gas supplier **270** may also supply the cleaning gas to the passage **305***a* in the chamber **302**. Each of these portions is a place where the mixing of the first gas (Si-containing gas, and the like) and the second gas (NH_3 gas, and the like) is likely to occur and the foreign substances to be removed in the cleaning process are likely to accumulate. Even in such a case, the third gas supplier **270** may supply a fresh (non-deactivated) cleaning gas to each portion where the foreign substances tend to be accumulated. This makes it possible to improve the efficiency of the cleaning process performed on each portion. (s) According to the embodiments of the present disclosure, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the stop of exhaust by the first gas exhauster **334**, and the execution of exhaust by the second gas exhauster **335** are performed in parallel, or the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the execution of exhaust by the first gas exhauster **334**, and the stop of exhaust by the second gas exhauster **335** are performed in parallel. Therefore, when the gas flow generated by the exhaust system of the first gas exhauster **334** or the second gas exhauster **335** is stopped during the cleaning process performed on the exhaust buffer structure **386**, the cleaning gas reaches the entire exhaust buffer structure **386**. Therefore, the entire exhaust buffer structure **386** may be cleaned without omission. (t) According to the embodiments of the present disclosure, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, and the exhaust control by which the amount of exhaust by the first gas exhauster **334** becomes larger than the amount of exhaust by the second gas exhauster **335** are performed in parallel, or the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, and the exhaust control by which the amount of exhaust by the first gas exhauster **334** becomes smaller than the amount of exhaust by the second gas exhauster **335** are performed in parallel. Therefore, the volume of exhaust by the exhaust system of the first gas exhauster **334** or the second gas exhauster **335** is made small during the cleaning process performed on the exhaust buffer structure **386**, whereby even when the gas flow generated by the exhaust system is not completely stopped, the cleaning gas may reach the entire exhaust buffer structure **386** easily. Therefore, the entire exhaust buffer structure **386** may be cleaned without omission. (u) According to the embodiments of the present disclosure, the cleaning gas supply from the third gas supplier **270** to the exhaust buffer structure **386**, the stop of exhaust performed by the first gas exhauster **334** and the stop of exhaust performed by the second gas exhauster **335** are performed in parallel. Therefore, the gas flows generated by the first gas exhauster **334** and the second gas exhauster **335** may be stopped during the cleaning process performed on the exhaust buffer structure **386**, which may confine the cleaning gas in the exhaust buffer structure **386**. This may be used in improving the efficiency of the cleaning process performed on the exhaust buffer structure **386**. (v) According to the embodiments of the present disclosure, the cleaning gas is confined in the exhaust buffer structure **386**. This may be used when a portion where the cleaning gas may not enter easily, such as the protrusion **390** of the exhaust buffer structure **386**, is provided in the exhaust buffer structure **386**. That is, since the cleaning gas may be supplied to the portion where the cleaning gas may not enter easily, the exhaust buffer structure **386** may be cleaned without omission.

(5) Modifications

(135) Although the embodiments of the present disclosure are specifically described above, the present disclosure is not limited thereto, and various changes may be made without departing from the gist thereof.

(136) For example, in the above-described embodiments, the DCS gas is taken as an example of the precursor gas which is the first gas. However, the present disclosure is not limited thereto. As the precursor gas, in addition to the DCS gas, it may be possible to use a chlorosilane precursor gas containing Si—Cl bonds, such as a hexachlorodisilane (Si_2C_6, abbreviation: HCDS) gas, a monochlorosilane (SiH_3Cl, abbreviation: MCS) gas, a trichlorosilane ($SiHCl_3$, abbreviation: TCS) gas, a tetrachlorosilane ($SiCl_4$, abbreviation: STC) gas, an octachlorotrisilane (Si_3Cl_8, abbreviation: OCTS) gas, or the like.

(137) Further, for example, in the above-described embodiments, the NH_3 gas is taken as an

example of the reaction gas which is the second gas. However, the present disclosure is not limited thereto. As the reaction gas, in addition to the NH_3 gas, it may be possible to use a hydrogen nitride-based gas containing N—H bonds such as a diazene (N_2H_2) gas, a hydrazine (N_2H_4) gas, a N_3H_8 gas, or the like.
(138) Further, for example, in the above-described embodiments, the N_2 gas is taken as an example of the inert gas. However, the present disclosure is not limited thereto. As the inert gas, in addition to the N_2 gas, it may be possible to use a rare gas such as an Ar gas, a He gas, a Ne gas, a Xe gas, or the like.
(139) Further, in the above-described embodiments, the film-forming process performed on the substrate **100** is taken as an example of the substrate processing process. However, the present disclosure is not limited thereto. The present disclosure may be applied to other processes as long as the processes include gas supply and gas exhaust. Examples of other processes include a diffusion process, an oxidation process, a nitriding process, an oxynitriding process, a reduction process, an oxidation-reduction process, an etching process, a heating process, and the like.
(6) Aspects of Present Disclosure
(140) Hereinafter, some aspects of the present disclosure will be additionally described as supplementary notes.
(141) (Supplementary Note 1)
(142) According to some embodiments of the present disclosure, there is provided a substrate processing apparatus, including: a process container configured to process one or more substrates; a support installed inside the process container and configured to support the one or more substrates on a plane of the support; a first gas supplier configured to supply a first gas to a first domain set in the process container; a second gas supplier configured to supply a second gas to a second domain set in the process container; an exhaust buffer structure installed along an outer circumference of the support; a first gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the first gas supplied from the first gas supplier; a second gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the second gas supplied from the second gas supplier; and a third gas supplier configured to supply a cleaning gas to the exhaust buffer structure.
(143) (Supplementary Note 2)
(144) The substrate processing apparatus of Supplementary Note 1 may further include an activator configured to activate the cleaning gas.
(145) (Supplementary Note 3)
(146) In the substrate processing apparatus of Supplementary Note 1 or 2, the third gas supplier may be configured to be capable of supplying, as the cleaning gas, a first cleaning gas capable of removing a carbon-containing film and a second cleaning gas capable of removing a carbon-free film, and the third gas supplier may be configured to supply the first cleaning gas and then supply the second cleaning gas when the cleaning gas is supplied to the exhaust buffer structure.
(147) (Supplementary Note 4)
(148) The substrate processing apparatus of Supplementary Note 2 may further include: a fourth gas supplier configured to supply a cleaning gas onto the support; and a heater configured to heat the support.
(149) (Supplementary Note 5)
(150) In the substrate processing apparatus of Supplementary Note 4, the fourth gas supplier may be installed higher than the third gas supplier in a gravity direction (vertical direction).
(151) (Supplementary Note 6)
(152) In the substrate processing apparatus of Supplementary Note 4 or 5, the third gas supplier may be configured to supply a cleaning gas to the exhaust buffer structure in a state where the activator is in operation, and the fourth gas supplier may be configured to supply a cleaning gas onto the support in a state where the heater is in operation.

(153) (Supplementary Note 7)
(154) In the substrate processing apparatus of Supplementary Note 2 or 6, the activator may be any one of a plasma generator, a heating catalyst, a second heater, and a microwave supplier.
(155) (Supplementary Note 8)
(156) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include a controller configured to be capable of controlling the third gas supplier and the fourth gas supplier such that a partial pressure of the cleaning gas when the third gas supplier performs the cleaning of the exhaust buffer structure is higher than a partial pressure of the cleaning gas when the fourth gas supplier performs the cleaning on the support
(157) (Supplementary Note 9)
(158) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include a controller configured to be capable of controlling the third gas supplier and the fourth gas supplier such that a frequency of the cleaning of the exhaust buffer structure performed by the third gas supplier is higher than a frequency of the cleaning performed on the support by the fourth gas supplier.
(159) (Supplementary Note 10)
(160) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include a controller configured to be capable of controlling the third gas supplier and the fourth gas supplier such that a supply time of the cleaning gas supplied by the third gas supplier to the exhaust buffer structure is longer than a supply time of the cleaning gas supplied by the fourth gas supplier onto the support.
(161) (Supplementary Note 11)
(162) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include a controller configured to be capable of controlling the third gas supplier and the fourth gas supplier such that the supply of the cleaning gas onto the support by the fourth gas supplier is stopped and the supply of the cleaning gas to the exhaust buffer structure by the third gas supplier is started after a predetermined time has elapsed from the supply of the cleaning gas onto the support by the fourth gas supplier.
(163) (Supplementary Note 12)
(164) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include a controller configured to be capable of controlling the third gas supplier and the fourth gas supplier such that the number of times the cleaning gas is supplied by the third gas supplier to the exhaust buffer structure is larger than the number of times the cleaning gas is supplied by the fourth gas supplier onto the support.
(165) (Supplementary Note 13)
(166) The substrate processing apparatus of any one of Supplementary Notes 4 to 6 may further include: a second activator configured to be capable of activating the cleaning gas supplied by the fourth gas supplier; and a controller configured to control the activator and the second activator such that an amount of activation energy of the activator with respect to the cleaning gas supplied by the third gas supplier is larger than an amount of activation energy of the second activator with respect to the cleaning gas supplied by the fourth gas supplier.
(167) (Supplementary Note 14)
(168) In the substrate processing apparatus of any one of Supplementary Notes 4 to 6, the cleaning gas supplied from the third gas supplier and the cleaning gas supplied from the fourth gas supplier may be different in components from each other
(169) (Supplementary Note 15)
(170) The substrate processing apparatus of Supplementary Note 1 may further includes: an inert gas supplier configured to supply an inert gas into the process container; and a controller configured to be capable of controlling the inert gas supplier and the third gas supplier such that the inert gas is supplied from the inert gas supplier in parallel with the cleaning gas supply to the

exhaust buffer structure by the third gas supplier.
(171) (Supplementary Note 16)
(172) In the substrate processing apparatus of Supplementary Note 15, the controller may be configured to be capable of controlling the inert gas supplier and the third gas supplier such that a partial pressure over the support is higher than a partial pressure in the exhaust buffer structure while the third gas supplier supplies the cleaning gas to the exhaust buffer structure.
(173) (Supplementary Note 17)
(174) In the substrate processing apparatus of Supplementary Note 15 or 16, the support may include through-holes through which lift pins configured to support the substrates pass, and the controller may be configured to be capable of controlling the inert gas supplier and the third gas supplier such that, while the third gas supplier supplies the cleaning gas to the exhaust buffer structure, a partial pressure over the through-holes is higher than a partial pressure in the exhaust buffer structure.
(175) (Supplementary Note 18)
(176) In the substrate processing apparatus of Supplementary Note 15, the third gas supplier may be arranged between the first gas supplier or the second gas supplier and exhaust holes included in the exhaust buffer structure in a gravity direction (vertical direction) and may be arranged between the first gas supplier and the second gas supplier in a direction (horizontal direction) orthogonal to the gravity direction.
(177) (Supplementary Note 19)
(178) In the substrate processing apparatus of Supplementary Note 1, the third gas supplier may be installed at a downstream side of a gas flow in a purge domain set between the first domain and the second domain.
(179) (Supplementary Note 20)
(180) In the substrate processing apparatus of Supplementary Note 1, the process container may include a gate valve capable of being opened and closed, and a passage provided between the gate valve and the support, and the third gas supplier may be configured to be capable of supplying the cleaning gas to the passage.
(181) (Supplementary Note 21)
(182) The substrate processing apparatus of Supplementary Note 1 may further include a controller configured to be capable of controlling the first gas exhauster, the second gas exhauster, and the third gas supplier such that: the supply of the cleaning gas from the third gas supplier to the exhaust buffer structure, stop of exhaust by the first gas exhauster, and execution of exhaust by the second gas exhauster are performed in parallel; or the supply of the cleaning gas from the third gas supplier to the exhaust buffer structure, execution of the exhaust by the first gas exhauster, and stop of the exhaust by the second gas exhauster are performed in parallel.
(183) (Supplementary Note 22)
(184) The substrate processing apparatus of Supplementary Note 1 may further include a controller configured to be capable of controlling the first gas exhauster, the second gas exhauster, and the third gas supplier such that: the supply of the cleaning gas from the third gas supplier to the exhaust buffer structure, and an exhaust control by which an amount of exhaust by the first gas exhauster becomes larger than an amount of exhaust by the second gas exhauster are performed in parallel; or the supply of the cleaning gas from the third gas supplier to the exhaust buffer structure, and an exhaust control by which the amount of exhaust by the first gas exhauster becomes smaller than the amount of exhaust by the second gas exhauster are performed in parallel.
(185) (Supplementary Note 23)
(186) The substrate processing apparatus of Supplementary Note 1 may further include a controller configured to be capable of controlling the first gas exhauster, the second gas exhauster, and the third gas supplier such that the supply of the cleaning gas from the third gas supplier to the exhaust buffer structure, stop of exhaust performed by the first gas exhauster, and stop of exhaust

performed by the second gas exhauster are performed in parallel.
(187) (Supplementary Note 24)
(188) In the substrate processing apparatus of Supplementary Note 1, the third gas supplier may be installed at a downstream side of a gas flow in a purge domain set between the first domain and the second domain, and a distance in the purge domain between an outer peripheral wall constituting the exhaust buffer structure and the support is set smaller than a distance in the first domain between the outer peripheral wall and the support and a distance in the second domain between the outer peripheral wall and the support.
(189) (Supplementary Note 25)
(190) According to some embodiments of the present disclosure, there is provided a method of manufacturing a semiconductor device, including: supporting one or more substrates on a plane of a support installed inside a process container; processing the substrates by performing first gas supply from a first gas supplier to a first domain set in the process container, second gas supply from a second gas supplier to a second domain set in the process container, exhaust from a first gas exhauster connected to an exhaust buffer structure installed along an outer periphery of the support and installed at a downstream side of a gas flow generated by the first gas supplier, and exhaust from a second gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a gas flow generated by the second gas supplier; unloading the substrates from the process container; and cleaning an inside of the exhaust buffer structure by supplying a cleaning gas from a third gas supplier connected to the exhaust buffer structure.
(191) (Supplementary Note 26)
(192) According to some embodiments of the present disclosure, there is provided a program that causes, by a computer, a substrate processing apparatus to perform a process including: supporting one or more substrates on a plane of a support installed inside a process container; processing the substrates by performing first gas supply from a first gas supplier to a first domain set in the process container, second gas supply from a second gas supplier to a second domain set in the process container, exhaust from a first gas exhauster connected to an exhaust buffer structure installed along an outer periphery of the support and installed at a downstream side of a gas flow generated by the first gas supplier, and exhaust from a second gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a gas flow generated by the second gas supplier; unloading the substrates from the process container; and cleaning an inside of the exhaust buffer structure by supplying a cleaning gas from a third gas supplier connected to the exhaust buffer structure.
(193) According to some embodiments of the present disclosure, it is possible to improve a cleaning efficiency of an exhaust system by supplying a cleaning gas to an exhaust buffer structure.
(194) While certain embodiments are described above, these embodiments are presented by way of example and are not intended to limit the scope of the disclosures. Indeed, the embodiments described herein may be embodied in a variety of other forms. Furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the disclosures. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the disclosures.

Claims

1. A substrate processing apparatus, comprising: a process container configured to process one or more substrates; a support installed inside the process container and configured to support the one or more substrates on a plane of the support; a first gas supplier configured to be capable of supplying a first gas to a first domain set in the process container; a second gas supplier configured to be capable of supplying a second gas to a second domain set in the process container; an exhaust

buffer structure installed along an outer circumference of the support; a first gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the first gas supplied from the first gas supplier; a second gas exhauster connected to the exhaust buffer structure and installed at a downstream side of a flow of the second gas supplied from the second gas supplier; a third gas supplier configured to be capable of supplying a first cleaning gas to the exhaust buffer structure; a fourth gas supplier configured to be capable of supplying a second cleaning gas onto the support; and a controller configured to control the third gas supplier and the fourth gas supplier to thereby control a frequency of each of the supplying of the first cleaning gas and the supplying of the second cleaning gas, a supply time of each of the first cleaning gas and the second cleaning gas, or a number of times for supplying each of the first cleaning gas and the second cleaning gas, such that over-etching in the support is prevented, wherein the third gas supplier is installed at a downstream side of a gas flow in a purge domain set between the first domain and the second domain, wherein a protrusion is provided at a portion of the exhaust buffer structure, which is adjacent to the purge domain, and is not provided at another portion of the exhaust buffer structure, which is adjacent to the first domain and the second domain, and wherein a distance in the purge domain between an outer peripheral wall constituting the exhaust buffer structure and the support is set to be smaller than a distance in the first domain between the outer peripheral wall and the support and a distance in the second domain between the outer peripheral wall and the support.

2. The substrate processing apparatus of claim 1, further comprising an activator configured to be capable of activating the first cleaning gas.

3. The substrate processing apparatus of claim 1, wherein the third gas supplier is configured to be capable of supplying the first cleaning gas capable of removing a carbon-containing film and a third cleaning gas capable of removing a carbon-free film, and wherein the third gas supplier is configured to supply the first cleaning gas and then supply the third cleaning gas when the first cleaning gas and the third cleaning gas are supplied to the exhaust buffer structure.

4. The substrate processing apparatus of claim 1, wherein the fourth gas supplier is installed higher than the third gas supplier in a gravity direction (vertical direction).

5. The substrate processing apparatus of claim 1, control the third gas supplier and the fourth gas supplier such that: a partial pressure of the first cleaning gas when the third gas supplier performs the cleaning of the exhaust buffer structure is higher than a partial pressure of the second cleaning gas when the fourth gas supplier performs the cleaning on the support; or a frequency of the cleaning of the exhaust buffer structure performed by the third gas supplier is higher than a frequency of the cleaning performed on the support by the fourth gas supplier.

6. The substrate processing apparatus of claim 1, wherein the controller is further configured to control the third gas supplier and the fourth gas supplier such that: a supply time of the first cleaning gas supplied by the third gas supplier to the exhaust buffer structure is longer than a supply time of the second cleaning gas supplied by the fourth gas supplier onto the support; the supply of the second cleaning gas onto the support by the fourth gas supplier is stopped and the supply of the first cleaning gas to the exhaust buffer structure by the third gas supplier is started after a predetermined time has elapsed from the supply of the second cleaning gas onto the support by the fourth gas supplier; or the number of times the first cleaning gas is supplied by the third gas supplier to the exhaust buffer structure is larger than the number of times the second cleaning gas is supplied by the fourth gas supplier onto the support.

7. The substrate processing apparatus of claim 1, further comprising: a first activator configured to be capable of activating the first cleaning gas supplied by the third gas supplier; and a second activator configured to be capable of activating the second cleaning gas supplied by the fourth gas supplier, and wherein the controller is further configured to control the first activator and the second activator such that an amount of activation energy of the first activator with respect to the first cleaning gas supplied by the third gas supplier is larger than an amount of activation energy of

the second activator with respect to the second cleaning gas supplied by the fourth gas supplier.

8. The substrate processing apparatus of claim 1, wherein the third gas supplier is connected to a first cleaning gas supply source, wherein the fourth gas supplier is connected to a second cleaning gas supply source, and wherein the first cleaning gas supplied from the third gas supplier and the second cleaning gas supplied from the fourth gas supplier are different in components from each other.

9. The substrate processing apparatus of claim 1, further comprising: an activator configured to be capable of activating the first cleaning gas; and a heater configured to be capable of heating the support, wherein the third gas supplier is configured to supply the first cleaning gas to the exhaust buffer structure in a state in which the activator is in operation, and wherein the fourth gas supplier is configured to supply the second cleaning gas onto the support in a state in which the heater is in operation.

10. The substrate processing apparatus of claim 1, further comprising: an inert gas supplier configured to supply an inert gas into the process container; wherein the controller is further configured to control the inert gas supplier and the third gas supplier such that the inert gas is supplied from the inert gas supplier in parallel with the supply of the first cleaning gas to the exhaust buffer structure by the third gas supplier.

11. The substrate processing apparatus of claim 10, wherein the controller is configured to control the inert gas supplier and the third gas supplier such that a partial pressure over the support is higher than a partial pressure in the exhaust buffer structure while the third gas supplier supplies the first cleaning gas to the exhaust buffer structure.

12. The substrate processing apparatus of claim 10, wherein the support includes through-holes through which lift pins configured to support the substrates pass, and wherein the controller is configured to control the inert gas supplier and the third gas supplier such that, while the third gas supplier supplies the first cleaning gas to the exhaust buffer structure, a partial pressure over the through-holes is higher than a partial pressure in the exhaust buffer structure.

13. The substrate processing apparatus of claim 1, wherein the third gas supplier is arranged between the first gas supplier or the second gas supplier and exhaust holes included in the exhaust buffer structure in a gravity direction and is arranged between the first gas supplier and the second gas supplier in a direction orthogonal to the gravity direction.

14. The substrate processing apparatus of claim 1, wherein the process container includes a gate valve capable of being opened and closed, and a passage provided between the gate valve and the support, and wherein the third gas supplier is configured to be capable of supplying the first cleaning gas to the passage.

15. The substrate processing apparatus of claim 1, wherein the controller is further configured to control the first gas exhauster, the second gas exhauster, and the third gas supplier such that: the supply of the first cleaning gas from the third gas supplier to the exhaust buffer structure, stop of the exhaust by the first gas exhauster, and execution of exhaust by the second gas exhauster are performed in parallel; or the supply of the first cleaning gas from the third gas supplier to the exhaust buffer structure, execution of the exhaust by the first gas exhauster, and stop of the exhaust by the second gas exhauster are performed in parallel.

16. The substrate processing apparatus of claim 1, wherein the controller is further configured to control the first gas exhauster, the second gas exhauster, and the third gas supplier such that: the supply of the first cleaning gas from the third gas supplier to the exhaust buffer structure, and an exhaust control by which an amount of exhaust by the first gas exhauster becomes larger than an amount of exhaust by the second gas exhauster are performed in parallel; or the supply of the first cleaning gas from the third gas supplier to the exhaust buffer structure, and an exhaust control by which the amount of exhaust by the first gas exhauster becomes smaller than the amount of exhaust by the second gas exhauster are performed in parallel.

17. The substrate processing apparatus of claim 1, wherein the controller is further configured to

control the first gas exhauster, the second gas exhauster, and the third gas supplier such that the supply of the first cleaning gas from the third gas supplier to the exhaust buffer structure, stop of the exhaust performed by the first gas exhauster, and stop of the exhaust performed by the second gas exhauster are performed in parallel.