SUBSTRATE PROCESSING APPARATUS AND CLEANING METHOD FOR SUBSTRATE PROCESSING APPARATUS

FIELD

[0001] A disclosed embodiment(s) relate(s) to a substrate processing apparatus and a cleaning method for a substrate processing apparatus.

BACKGROUND

[0002] A technique has conventionally been known that cleans an inside of a recovery pipe that recovers a used processing liquid in a substrate processing apparatus for processing a single substrate where a substrate such as a semiconductor wafer (that will also be called a wafer below) is processed one by one (see Japanese Patent Application Publication No. 2015-220318).

[0004] The present disclosure provides a technique that is capable of efficiently cleaning an inside of a supply pipe that supplies a processing liquid to a nozzle.

SUMMARY

[0005] According to one embodiment of the present disclosure, there is provided a substrate processing apparatus includes: a holding unit, a nozzle, a supply pipe, a supply valve, a drain pipe, a drain valve, and a

controller. The holding unit holds and rotates a substrate. The nozzle discharges a liquid to the substrate that is held by the holding unit. The supply pipe supplies a liquid to the nozzle. The supply valve is provided on the supply pipe. The drain pipe is connected to the supply pipe on a downstream side of the supply valve and discharges a liquid inside the supply pipe. The drain valve is provided on the drain pipe. The controller controls each unit. Furthermore, the controller executes a cleaning recipe that supplies a cleaning liquid to an inside of the supply pipe and an inside of the drain pipe in a state where the supply valve and the drain valve are opened simultaneously, so that an inside of the drain pipe is cleaned.

BRIEF DESCRIPTION OF DRAWING(S)

[0007] FIG. 1 is a schematic diagram that illustrates a general configuration of a substrate processing system according to an embodiment;

FIG. 2 is a schematic diagram that illustrates an example of a specific configuration of a processing unit according to an embodiment;

FIG. 3 is a diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle according to an embodiment;

FIG. 4 is a diagram for explaining a cleaning process for a supply pipe in a reference example;

FIG. 5 is a diagram for explaining a cleaning process for a supply pipe in a reference example;

FIG. 6 is a diagram for explaining a cleaning process for a supply pipe in a reference example;

FIG. 7 is a timing chart that illustrates an example of a cleaning process for a supply pipe according to an embodiment;

FIG. 8 is a diagram for explaining a cleaning process for a supply pipe according to an embodiment;

FIG. 9 is a diagram for explaining a cleaning process for a supply pipe according to an embodiment;

FIG. 10 is a diagram for explaining a cleaning process for a supply pipe according to an embodiment;

FIG. 11 is a timing chart that illustrates an example of a cleaning process for a supply pipe according to variation 1 of an embodiment;

FIG. 12 is a diagram for explaining a cleaning process for a supply pipe according to variation 1 of an embodiment;

FIG. 13 is a diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle according to variation 2 of an embodiment;

FIG. 14 is a diagram for explaining a cleaning process

for a supply pipe according to variation 2 of an embodiment;

FIG. 15 is a diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle according to variation 3 of an embodiment;

FIG. 16 is a diagram for explaining a cleaning process for a supply pipe according to variation 3 of an embodiment;

FIG. 17 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system according to an embodiment;

FIG. 18 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system according to variation 1 of an embodiment;

FIG. 19 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system according to variation 2 of an embodiment; and

FIG. 20 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system according to variation 3 of an embodiment.

DESCRIPTION OF EMBODIMENT(S)

[0008] Hereinafter, an embodiment(s) of a substrate processing apparatus and a cleaning method for a substrate processing apparatus as disclosed in the present application will be explained in detail with reference to the accompanying drawing(s). Additionally, the present disclosure is not limited by an embodiment(s) as illustrated below. Furthermore, it has to be noted that the drawing(s) is/are schematic where a relationship between dimensions of respective elements, a ratio of such respective elements, etc., may be different from an actual one(s). Moreover, pars where a relationship between and/or a ratio of respective dimensions is/are different between respective drawings may also be included therein.

[0009] A technique has conventionally been known that cleans an inside of a recovery pipe that recovers a used processing liquid in a substrate processing apparatus for processing a single substrate where a substrate such as a semiconductor wafer (that will also be called a wafer below) is processed one by one.

[0010] Furthermore, at an activation step immediately after a substrate processing apparatus is installed in a factory, an inside of a supply pipe that supplies a processing liquid to a nozzle is not provided in a sufficiently cleaned state thereof, so that a process that also cleans such an inside of a supply pipe is needed.

[0011] However, in such a cleaning step for a supply pipe, a phenomenon where a contaminated liquid flows backward to such a supply pipe is caused in a drain pipe that is connected between such a supply pipe and a drain section, due to a suck back process, so that it takes a very long time to complete a process that cleans an inside of such a supply pipe.

[0012] Hence, realization of a technique that is capable of overcoming a problem(s) as described above and cleaning an inside of a supply pipe efficiently is expected.

[0013] Outline of Substrate Processing System

First, a general configuration of a substrate processing system 1 according to an embodiment will be explained with reference to FIG. 1. FIG. 1 is a diagram that illustrates a general configuration of a substrate processing system 1 according to an embodiment. Such a substrate processing system 1 is an example of a substrate processing apparatus. Hereinafter, in order to clarify a positional relationship, an X-axis, a Y-axis, and a Z-axis that are orthogonal to one another are specified where a positive direction of such a Z-axis is provided as a vertically upward direction.

[0014] As illustrated in FIG. 1, the substrate processing system 1 includes a carry-in/out station 2 and a processing station 3. The carry-in/out station 2 and the

processing station 3 are provided adjacently.

[0015] The carry-in/out station 2 includes a hoop placing section 11 and a transfer section 12. In the hoop placing section 11, a plurality of hoops H are placed that house a plurality of substrates, in an embodiment, semiconductor wafers W (that will be called wafers W below), in a horizontal state thereof.

[0016] The transfer section 12 is provided so as to be adjacent to the hoop placing section 11 and includes a substrate transfer device 13 and a delivery unit 14 in an inside thereof. The substrate transfer device 13 includes a wafer holding mechanism that holds a wafer W. Furthermore, the substrate transfer device 13 is capable of moving in a horizontal direction and a vertical direction and turning around a vertical axis as a center thereof, and executes transfer of a wafer W between a hoop H and the delivery unit 14 by using a wafer holding mechanism.

[0017] The processing station 3 is provided so as to be adjacent to the transfer section 12. The processing station 3 includes a transfer section 15 and a plurality of processing units 16. The plurality of processing units 16 are provided side by side on both sides of the transfer section 15.

[0018] The transfer section 15 includes a substrate transfer device 17 in an inside thereof. The substrate

transfer device 17 includes a wafer holding mechanism that holds a wafer W. Furthermore, the substrate transfer device 17 is capable of moving in a horizontal direction and a vertical direction and turning around a vertical axis as a center thereof, and executes transfer of a wafer W between the delivery unit 14 and a processing unit 16 by using a wafer holding mechanism.

[0019] A processing unit 16 executes predetermined substrate processing for a wafer W that is transferred by the substrate transfer device 17.

[0020] Furthermore, the substrate processing system 1 includes a control device 4. The control device 4 is, for example, a computer and includes a controller 18 and a storage 19. The storage 19 stores a program that controls various types of processes that are executed in the substrate processing system 1. The controller 18 reads and executes a program that is stored in the storage 19 so as to control an operation of the substrate processing system 1.

[0021] Additionally, such a program may be recorded in a computer-readable storage medium and installed in the storage 19 of the control device 4 from such a storage medium. For a computer-readable storage medium, for example, a hard disk (HD), a flexible disk (FD), a compact disk (CD), a magneto-optical disk (MO), a memory card,

etc., is/are provided.

[0022] In the substrate processing system 1 that is configured as described above, first, the substrate transfer device 13 of the carry-in/out station 2 takes a wafer W from a hoop H that is placed in the hoop placing section 11 and places such a taken wafer W on the delivery unit 14. A wafer W that is placed on the delivery unit 14 is taken from the delivery unit 14 and carried in a processing unit 16, by the substrate transfer device 17 of the processing station 3.

[0023] A wafer W that is carried in a processing unit 16 is processed by such a processing unit 16, subsequently carried out of such a processing unit 16 by the substrate transfer device 17, and placed on the delivery unit 14. Then, a processed wafer W that is placed on the delivery unit 14 is returned to a hoop H of the hoop placing section 11 by the substrate transfer device 13.

[0024] Configuration of Processing unit

Next, a configuration of a processing unit 16 according to an embodiment will be explained with reference to FIG. 2. FIG. 2 is a schematic diagram that illustrates an example of a specific configuration of a processing unit 16. As illustrated in FIG. 2, the processing unit 16 includes a chamber 20, a substrate processing unit 30, a liquid supply unit 40, and a recovery cup 50.

[0025] The chamber 20 houses the substrate processing unit 30, the liquid supply unit 40, and the recovery cup 50. An FFU (Fan Filter Unit) 21 is provided on a ceiling part of the chamber 20. The FFU 21 forms a downflow in the chamber 20.

[0026] The substrate processing unit 30 includes a holding unit 31, a supporting unit 32, and a driving unit 33, and applies liquid processing to a placed wafer W. The holding unit 31 holds a wafer W horizontally. The supporting unit 32 is a member that extends in a vertical direction where a proximal end part thereof is supported so as to be rotatable by the driving unit 33 and a distal end part thereof supports the holding unit 31 horizontally. The driving unit 33 rotates the supporting unit 32 around a vertical axis.

[0027] Such a substrate processing unit 30 rotates the supporting unit 32 by using the driving unit 33 so as to rotate the holding unit 31 that is supported by the supporting unit 32 and thereby rotate a wafer W that is held by the holding unit 31.

[0028] The holding unit 31 adsorbs, for example, a lower surface of a wafer W so as to hold such a wafer W horizontally. Additionally, the holding unit 31 is not limited to an adsorption chuck and may be an electrostatic chuck, a chuck that grips a peripheral part of a wafer W,

etc. Additionally, a wafer W is held by the holding unit 31 in a state where a surface where substrate processing is executed is oriented upwardly.

[0029] The liquid supply unit 40 supplies a processing fluid to a wafer W. The liquid supply unit 40 includes a nozzle 41, an arm 42 that supports the nozzle 41 horizontally, and a turning/lifting/lowering mechanism 43 that turns and lifts or lowers the arm 42.

[0030] The nozzle 41 is connected to a processing liquid supply source 46a through a valve 44a and a flow rate regulator 45a. The processing liquid supply source 46a is, for example, a tank that stores various types of processing liquids.

[0031] Additionally, although the liquid supply unit 40 that is capable of supplying one type of processing liquid to the nozzle 41 is illustrated in an example of FIG. 2, the present disclosure is not limited to such an example and may be configured to be capable of supplying two or more types of processing liquids to the nozzle 41.

[0032] Furthermore, the nozzle 41 is connected to a cleaning liquid supply source 46b through a valve 44b and a flow rate regulator 45b. The cleaning liquid supply source 46b is, for example, a tank that stores a cleaning liquid L (see FIG. 4) that cleans an inside of a supply pipe 100 (see FIG. 3).

[0033] A cleaning liquid L according to an embodiment is, for example, a DIW (a DeIonized Water: a deionized water) at an ordinary temperature (20°C to 25°C), a DIW at a high temperature (50°C to 80°C), or a SC1 (a mixed liquid of ammonia, an aqueous solution of hydrogen peroxide, and water) at a temperature of 20°C to 80°C, etc. A detail(s) of a cleaning process for a supply pipe 100 that uses such a cleaning liquid L will be described later.

[0034] The recovery cup 50 is arranged so as to surround the holding unit 31 and collects a processing liquid that is scattered from a wafer W due to rotation of the holding unit 31. A drain port 51 is formed on a bottom part of the recovery cup 50 and a cleaning liquid that is collected by the recovery cup 50 is discharged from such a drain port 51 to an outside of the processing unit 16. Furthermore, an exhaust port 52 that discharges a gas that is supplied from the FFU 21 to an outside of the processing unit 16 is formed on a bottom part of the recovery cup 50.

[0035] Detail(s) of Cleaning Process

Next, a detail(s) of a cleaning process according to an embodiment will be explained with reference to FIG. 3 to FIG. 10. FIG. 3 is a diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle 41 according to an embodiment. As illustrated in FIG. 3, a liquid supply unit 40 of a processing unit 16 according to

an embodiment has a nozzle 41, a supply pipe 100, and a drain pipe 110.

[0036] The supply pipe 100 is a pipe that supplies a processing liquid that is stored in a processing liquid supply source 46a (see FIG. 2) or a cleaning liquid L (see FIG. 4) that is stored in a cleaning liquid supply source 46b (see FIG. 2) to the nozzle 41.

[0037] The supply pipe 100 is provided with a connection part 101, a supply valve 102, a constant-pressure valve 103, and a flowmeter 104 sequentially from a downstream side thereof, with respect to the nozzle 41. The connection part 101 of the supply pipe 100 is connected to the drain pipe 110. That is, the drain pipe 110 is branched from the connection part 101 of the supply pipe 100.

[0038] The supply valve 102 is configured to be openable and closable by a controller 18 (see FIG. 1). Then, in a case where the supply valve 102 is provided in an open state thereof, the supply valve 102 causes a processing liquid or a cleaning liquid L to pass and flow therethrough. On the other hand, in a case where the supply valve 102 is provided in a closed state thereof, the supply valve 102 prevents a processing liquid or a cleaning liquid L from passing or flowing therethrough.

[0039] The constant-pressure valve 103 regulates a

pressure of a processing liquid or a cleaning liquid L on a secondary side (a downstream side) thereof so as to be a predetermined pressure. The flowmeter 104 measures a flow rate of a processing liquid or a cleaning liquid L that flows through the supply pipe 100.

[0040] The drain pipe 110 discharges a processing liquid or a cleaning liquid L in the supply pipe 100 to a drain section DR. The drain pipe 110 is provided in order to reduce or prevent dripping of a processing liquid from a tip of the nozzle 41, etc. The drain pipe 110 is provided with a drain valve 111.

[0041] The drain valve 111 is configured to be openable and closable by the controller 18. Then, in a case where the drain valve 111 is provided in an open state thereof, the drain valve 111 causes a processing liquid or a cleaning liquid L to pass and flow therethrough. On the other hand, in a case where the drain valve 111 is provided in a closed state thereof, the drain valve 111 prevents a processing liquid or a cleaning liquid L from passing or flowing therethrough.

[0042] Next, an example of a cleaning process for a supply pipe 100 in a reference example will be explained. FIG. 4 to FIG. 6 are diagrams for explaining a cleaning process for a supply pipe 100 in a reference example.

[0043] In such a reference example, first, as

illustrated in FIG. 4, a controller 18 (see FIG. 1) controls a supply valve 102 so as to be an open state thereof and controls a drain valve 111 so as to be a closed state thereof. Thereby, the controller 18 supplies a cleaning liquid L to the supply pipe 100 so as to clean an inside of the supply pipe 100 with such a cleaning liquid L.

[0044] Additionally, in the drawing(s) for the present disclosure, a valve in an open state thereof is provided with "O" and a valve in a closed state thereof is provided with "C", in order to facilitate understanding thereof.

[0045] Furthermore, in such a passing and flowing process for a cleaning liquid L, as illustrated in FIG. 4, a contaminated liquid Lc that flows backward from a drain section DR is present in a drain pipe 110 on a downstream side of the drain valve 111. Such a contaminated liquid Lc is a liquid that is discharged from various places in a factory to the drain section DR, and hence, is a liquid with a degree of contamination that is higher than that of a cleaning liquid L.

[0046] Then, as illustrated in FIG. 5, a controller 18 (see FIG. 1) changes a supply valve 102 into a closed state thereof and changes a drain valve 111 into an open state thereof. Thereby, the controller 18 draws a cleaning liquid L that is located at a tip of a nozzle 41 to an

upstream side thereof and executes a suck back process that reduces or prevents dripping of such a cleaning liquid L from a tip of the nozzle 41.

[0047] Herein, a time lag is present after the supply valve 102 is controlled by the controller 18 so as to be a closed state thereof and before it is provided in a completely closed state thereof. Then, a flow of a cleaning liquid L toward the nozzle 41 is present in a supply pipe 100 until the supply valve 102 is provided in a completely closed state thereof.

[0048] On the other hand, at a time point of FIG. 5, the drain valve 111 is changed into an open state thereof, so that a contaminated liquid Lc flows backward to an upstream side of a drain pipe 110 due to a flow of a cleaning liquid L in the supply pipe 100 that is caused due to a time lag as described above. Such a backward flow is a phenomenon that is caused due to Bernoulli effect.

[0049] Thereby, as illustrated in FIG. 5, a cleaning liquid L is changed into a mixed liquid Lm in the drain pipe 110 on an upstream side of the drain valve 111 and/or a connection part 101 of the drain pipe 110 and a vicinity thereof. Such a mixed liquid Lm is a liquid where a cleaning liquid L and a contaminated liquid Lc are mixed, and is a liquid with a degree of contamination that is higher than that of such a cleaning liquid L.

[0050] Then, as illustrated in FIG. 6, as a supply valve 102 is provided in a completely closed state thereof, a cleaning liquid L that is located at a tip of a nozzle 41 is drawn to an upstream side thereof. Then, after a cleaning liquid L is drawn to an upstream side thereof for a predetermined time period (for example, about 2 seconds), a controller 18 (see FIG. 1) changes a drain valve 111 into a closed state thereof, and ends a suck back process. Thereby, a cleaning process for a supply pipe 100 in a reference example is ended.

[0051] However, in such a reference example, as illustrated in FIG. 6, even after a cleaning process for the drain pipe 110 is ended, a mixed liquid Lm is left in a part of the supply pipe 100 (for example, between a connection part 101 and the supply valve 102).

[0052] Hence, an inside of the supply pipe 100 is contaminated with a contaminant that is included in such a mixed liquid Lm again, so that it is difficult to clean such an inside of the supply pipe 100 efficiently.

[0053] Hence, in an embodiment, a cleaning process that will be explained below is executed so as to clean an inside of a supply pipe 100 efficiently. FIG. 7 is a timing chart that illustrates an example of a cleaning process for a supply pipe 100 according to an embodiment. Furthermore, FIG. 8 to FIG. 10 are diagrams for explaining

a cleaning process for a supply pipe 100 according to an embodiment.

[0054] Additionally, a cleaning process according to an embodiment is executed in such a manner that a controller 18 (see FIG. 1) reads a cleaning recipe that is preliminarily stored in a storage 19 (see FIG. 1).

[0055] In a cleaning process according to an embodiment, as illustrated in FIG. 7, a controller 18 (see FIG. 1) controls any of a supply valve 102 and a drain valve 111 so as to be provided in an open state thereof, at a time T01. Thereby, as illustrated in FIG. 8, a controller 18 (see FIG. 1) cleans an inside of a supply pipe 100 with a cleaning liquid L and cleans an inside of a drain pipe 110 with such a cleaning liquid L.

[0056] Then, as illustrated in FIG. 7, the controller 18 changes the supply valve 102 from an open state thereof to a closed state thereof, at a time T02 when a predetermined time period (for example, 30 seconds to 120 seconds) has passed since a time T01. Thereby, as illustrated in FIG. 9, a controller 18 (see FIG. 1) executes a suck back process that draws a cleaning liquid L that is located at a tip of a nozzle 41 to an upstream side thereof.

[0057] Herein, in an embodiment, a cleaning process for an inside of a drain pipe 110 with a cleaning liquid L is also executed prior to such a suck back process, so that it

is possible to reduce or prevent a backward flow of a contaminated liquid Lc (see FIG. 4) from a drain section DR to a supply pipe 100 in such a suck back process.

[0058] That is, in a cleaning process according to an embodiment, a drain pipe 110 is cleaned with a cleaning liquid L in parallel with a cleaning process for a supply pipe 100, so that it is possible to reduce or prevent contamination of the supply pipe 100 like a reference example as described above. Therefore, according to an embodiment, it is possible to clean an inside of the supply pipe 100 efficiently.

[0059] Furthermore, in a cleaning process according to an embodiment, it is preferable that a time period when a supply valve 102 and a drain valve 111 are opened simultaneously (that is, a time period from a time T01 to a time T02) is 30 seconds to 120 seconds. Thereby, it is possible to clean an inside of a supply pipe 100 and an inside of a drain pipe 110 sufficiently.

[0060] Furthermore, in a cleaning process according to an embodiment, it is preferable that an inside of a supply pipe 100 and an inside of a drain pipe 110 are cleaned with a cleaning liquid L simultaneously and subsequently a suck back process is executed that closes a supply valve 102 so as to draw a cleaning liquid L that is left in a nozzle 41. Thereby, it is possible to reduce or prevent dripping of a

cleaning liquid L from a tip of the nozzle 41.

[0061] Furthermore, in an embodiment, a cleaning liquid L may be a purified water (DIW) at an ordinary temperature. Thereby, it is possible to execute a cleaning process for a supply pipe 100 at low cost.

[0062] Furthermore, in an embodiment, a cleaning liquid L may be a purified water (DIW) at a high temperature. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0063] Furthermore, in an embodiment, a cleaning liquid L may be a SC1 at a temperature of 20°C to 80°C. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0064] Furthermore, in an embodiment, in a case where a cleaning liquid L is SC1, a mixing ratio of such a cleaning liquid L may be ammonia: an aqueous solution of hydrogen peroxide: water = 1: 1: 100 to 1: 1: 10. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0065] Furthermore, in an embodiment, an amount of a cleaning liquid L that is supplied to an inside of a supply pipe 100 and an inside of a drain pipe 110 may be 1000 (mL/min) to 1500 (mL/min). Thereby, it is possible to clean an inside of the supply pipe 100 more efficiently.

[0066] An explanation for FIG. 7 will be returned to.

As illustrated in FIG. 7, the controller 18 maintains the supply valve 102 in a closed state thereof and maintains the drain valve 111 in an open state thereof, from a time T02 to a time T03. Such a maintenance time period (that is, a time period from a time T02 to a time T03) is, for example, 30 seconds to 120 seconds.

[0067] Thus, as illustrated in FIG. 10, a cleaning liquid L is discharged from a supply pipe 100 for a time period that is longer than that of a usual suck back process, so that such a cleaning liquid L is discharged from an inside of the supply pipe 100 on a downstream side of a supply valve 102 and an inside of a drain pipe 110.

[0068] That is, in an embodiment, a cleaning liquid L is discharged from a supply pipe 100 for a time period that is longer than that of a usual suck back process, so that an inside of the supply pipe 100 on a downstream side of a supply valve 102 and an inside of a drain pipe 110 are dried. Thereby, it is possible to clean an inside of the supply pipe 100 more efficiently.

[0069] Variation 1

Next, various types of variations of a cleaning process according to an embodiment will be explained with reference to FIG. 11 to FIG. 16. FIG. 11 is a timing chart that illustrates an example of a cleaning process for a supply pipe 100 according to variation 1 of an embodiment.

[0070] In a cleaning process according to variation 1, as illustrated in FIG. 11, first, a controller 18 (see FIG. 1) controls any of a supply valve 102 and a drain valve 111 so as to be provided in an open state thereof, at a time T11. Thereby, as illustrated in FIG. 8, a controller 18 (see FIG. 1) cleans an inside of a supply pipe 100 with a cleaning liquid L and cleans an inside of a drain pipe 110 with such a cleaning liquid L.

[0071] Then, as illustrated in FIG. 11, the controller 18 changes the supply valve 102 from an open state thereof to a closed state thereof, at a time T12 when a predetermined time period (for example, 30 seconds to 120 seconds) has passed since a time T11. Thereby, as illustrated in FIG. 9, a controller 18 (see FIG. 1) executes a suck back process that draws a cleaning liquid L that is located at a tip of a nozzle 41 to an upstream side thereof.

[0072] Then, as illustrated in FIG. 11, the controller 18 changes the drain valve 111 from an open state thereof to a closed state thereof, at a time T13 when a predetermined time period (for example, about 2 seconds) has passed since a time T12. Thereby, as illustrated in FIG. 12, in a state where a cleaning liquid L that is located at a tip of a nozzle 41 is drawn to an upstream side thereof, a cleaning process is ended.

[0073] Thus, in a cleaning process according to variation 1, while a cleaning liquid L that is located at a tip of a nozzle 41 is drawn, such a cleaning liquid L is left at another site of a supply pipe 100.

[0074] Thereby, similarly to an embodiment as described above, a drain pipe 110 is cleaned with a cleaning liquid L in parallel with a cleaning process for a supply pipe 100, so that it is also possible to reduce or prevent contamination of the supply pipe 100 like a reference example as described above. Therefore, according to variation 1, it is possible to clean an inside of a supply pipe 100 efficiently.

[0075] Furthermore, in variation 1, a step that discharges a cleaning liquid L from an inside of a supply pipe 100 on a downstream side of a supply valve 102 and an inside of a drain pipe 110 is omitted, so that it is possible to execute a cleaning process for the supply pipe 100 in a shorter time period.

[0076] Variation 2

FIG. 13 is diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle 41 according to variation 2 of an embodiment. As illustrated in FIG. 13, variation 2 is different from an embodiment (see FIG. 3) as described above in that a first gas supply pipe 120 is provided in a liquid supply unit 40.

[0077] The first gas supply pipe 120 is connected to a connection part 112 of a drain pipe 110. Such a connection part 112 is provided on the drain pipe 110 on a downstream side of a drain valve 111. The first gas supply pipe 120 is provided with a first gas supply source 121 and a first gas supply valve 122 sequentially from an upstream side thereof.

[0078] The first gas supply source 121 is, for example, a tank that stores a drying gas G (see FIG. 14). Such a drying gas G is, for example, a dried nitrogen gas or a dried air, etc.

[0079] The first gas supply valve 122 is configured to be openable and closable by a controller 18. Then, in a case where the first gas supply valve 122 is provided in an open state thereof, the first gas supply valve 122 causes a drying gas G to pass and flow therethrough. On the other hand, in a case where the first gas supply valve 122 is provided in a closed state thereof, the first gas supply valve 122 prevents a drying gas G from passing or flowing therethrough.

[0080] Thus, the first gas supply pipe 120 that has the first gas supply source 121 and the first gas supply valve 122 has a function to supply a drying gas G to an inside of the drain pipe 110.

[0081] Next, a procedure of a cleaning process for a

supply pipe 100 according to variation 2 will be explained. In a cleaning process according to variation 2, first, a controller 18 (see FIG. 1) controls any of a supply valve 102 and a drain valve 111 so as to be provided in an open state thereof. Furthermore, at such a time point, a first gas supply valve 122 is controlled so as to be provided in a closed state thereof.

[0082] Thereby, as illustrated in FIG. 8, a controller 18 cleans an inside of a supply pipe 100 with a cleaning liquid L and cleans an inside of a drain pipe 110 with such a cleaning liquid L.

[0083] Then, the controller 18 changes a supply valve 102 from an open state thereof to a closes state thereof after a predetermined time period (for example, 30 seconds to 120 seconds) has passed since starting of a cleaning process. Thereby, as illustrated in FIG. 9, a controller 18 executes a suck back process that draws a cleaning liquid L that is located at a tip of a nozzle 41 to an upstream side thereof.

[0084] Then, the controller 18 changes a drain valve 111 from an open state thereof to a closed state thereof after a predetermined time period (for example, 30 seconds to 120 seconds) has passed since changing of a supply valve 102 to a closed state thereof. Thereby, as illustrated in FIG. 10, a controller 18 discharges a cleaning liquid L from an

inside of a supply pipe 100 on a downstream side of a supply valve 102 and an inside of a drain pipe 110.

[0085] Then, as illustrated in FIG. 14, a controller 18 (see FIG. 1) changes a first gas supply valve 122 from a closed state thereof to an open state thereof. Thereby, a drying gas G is supplied to a drain pipe 110 on a downstream side of a drain valve 111. Then, in variation 2, the controller 18 maintains the first gas supply valve 122 in an open state thereof, until a next cleaning process is executed.

[0086] Thereby, it is possible to reduce or prevent a backward flow of a contaminated liquid Lc (see FIG. 4) to the drain valve 111 of the drain pipe 110 until a next cleaning process is executed. Therefore, according to variation 2, it is possible to further reduce or prevent contamination of a supply pipe 100 like a reference example as described above, so that it is possible to clean an inside of the supply pipe 100 more efficiently.

[0087] Variation 3

FIG. 15 is a diagram that illustrates an example of a pipe configuration on an upstream side of a nozzle 41 according to variation 3 of an embodiment. As illustrated in FIG. 15, variation 3 is different from an embodiment (see FIG. 3) as described above in that a second gas supply pipe 130 is provided in a liquid supply unit 40.

[0088] The second gas supply pipe 130 is connected to a connection part 105 of a supply pipe 100. Such a connection part 105 is provided between a supply valve 102 and a connection part 101 in the supply pipe 100. The second gas supply pipe 130 is provided with a second gas supply source 131 and a second gas supply valve 132 sequentially from an upstream side thereof.

[0089] The second gas supply source 131 is, for example, a tank that stores a drying gas G (see FIG. 16). Such a drying gas G is, for example, a dried nitrogen gas or a dried air, etc.

[0090] The second gas supply valve 132 is configured to be openable and closable by a controller 18. Then, in a case where the second gas supply valve 132 is provided in an open state thereof, the second gas supply valve 132 causes a drying gas G to pass and flow therethrough. On the other hand, in a case where the second gas supply valve 132 is provided in a closed state thereof, the second gas supply valve 132 prevents a drying gas G to pass or flow therethrough.

[0091] Thus, the second gas supply pipe 130 that has the second gas supply source 131 and the second gas supply valve 132 has a function to supply a drying gas G to an inside of the supply pipe 100.

[0092] Next, a procedure of a cleaning process for a

supply pipe 100 according to variation 3 will be explained. In a cleaning process according to variation 3, first, a controller 18 (see FIG. 1) controls any of a supply valve 102 and a drain valve 111 so as to be provided in an open state thereof. Furthermore, at such a time point, a second gas supply valve 132 is controlled so as to be provided in a closed state thereof.

[0093] Thereby, as illustrated in FIG. 8, a controller 18 cleans an inside of a supply pipe 100 with a cleaning liquid L and cleans an inside of a drain pipe 110 with such a cleaning liquid L.

[0094] Then, the controller 18 changes a supply valve 102 from an open state thereof to a closed state thereof, after a predetermined time period (for example, 30 seconds to 120 seconds) has passed since starting of a cleaning process. Thereby, as illustrated in FIG. 9, a controller 18 executes a suck back process that draws a cleaning liquid L that is located at a tip of a nozzle 41 to an upstream side thereof.

[0095] Then, the controller 18 maintains a supply valve 102 in a closed state thereof and maintains a drain valve 111 in an open state thereof. Thereby, as illustrated in FIG. 16, a controller 18 (see FIG. 1) discharges a cleaning liquid L from an inside of a supply pipe 100 on a downstream side of a supply valve 102 and an inside of a

drain pipe 110.

[0096] Moreover, in variation 3, the controller 18 changes a second gas supply valve 132 from a closed state thereof to an open state thereof, in parallel with a discharge process for such a cleaning liquid L. Thereby, a drying gas G is supplied to a supply pipe 100 on a downstream side of a supply valve 102.

[0097] Then, in variation 3, such a drying gas G accelerates a drying process for an inside of the supply pipe 100 on a downstream side of the supply valve 102 and an inside of a drain pipe 110. Therefore, according to variation 3, it is possible to clean an inside of the supply pipe 100 more efficiently.

[0098] Additionally, in variation 3, a cleaning liquid L is discharged from an inside of the supply pipe 100 and an indie of the drain pipe 110, and subsequently, a drain valve 111 and a second gas supply valve 132 are changed so as to be provided in a closed state thereof. Thereby, a cleaning process in variation 3 is ended.

[0099] A substrate processing apparatus (a substrate processing system 1) according to an embodiment includes a holding unit 31, a nozzle 41, a supply pipe 100, a supply valve 102, a drain pipe 110, a drain valve 111, and a controller 18. The holding unit 31 holds and rotates a substrate (a wafer W). The nozzle 41 discharges a liquid

to the substrate (the wafer W) that is held by the holding unit 31. The supply pipe 100 supplies a liquid to the nozzle 41. The supply valve 102 is provided on the supply pipe 100. The drain pipe 110 is connected to the supply pipe 100 on a downstream side of the supply valve 102 and discharges a liquid inside the supply pipe 100. The drain valve 111 is provided on the drain pipe 110. The controller 18 controls each unit. Furthermore, the controller 18 executes a cleaning recipe that supplies a cleaning liquid L to an inside of the supply pipe 100 and an inside of the drain pipe 110 in a state where the supply valve 102 and the drain valve 111 are opened simultaneously, so that an inside of the drain pipe 110 is cleaned. Thereby, it is possible to clean an inside of a supply pipe 100 efficiently.

[0100] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, in the cleaning recipe, a time period when the supply valve 102 and the drain valve 111 are opened simultaneously is 30 seconds to 120 seconds. Thereby, it is possible to clean an inside of a supply pipe 100 and an inside of a drain pipe 110 sufficiently.

[0101] Furthermore, in the substrate processing apparatus according to an embodiment, in the cleaning recipe, the supply valve 102 and the drain valve 111 are

opened simultaneously so as to clean an inside of the drain pipe 110 and subsequently the supply valve 102 is closed and the drain valve 111 is opened so as to draw the cleaning liquid L that is left in the nozzle 41. Thereby, it is possible to reduce or prevent dripping of a cleaning liquid L from a tip of a nozzle 41.

[0102] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, in the cleaning recipe, a time period when the supply valve 102 is closed and the drain valve 111 is opened is 2 seconds to 120 seconds. Thereby, it is possible to clean an inside of a supply pipe 100 and an inside of a drain pipe 110 sufficiently.

[0103] Furthermore, the substrate processing apparatus (the substrate processing system 1) according to an embodiment further includes a first gas supply pipe 120, and a first gas supply valve 122. The first gas supply pipe 120 is connected to the drain pipe 110 on a downstream side of the drain valve 111 and supplies a drying gas G to an inside of the drain pipe 110. The first gas supply valve 122 is provided on the first gas supply pipe 120. Furthermore, in the cleaning recipe, the supply valve 102 is closed and the drain valve 111 is opened so as to draw the cleaning liquid L that is left in the nozzle 41 and subsequently the drain valve 111 is closed and the first

gas supply valve 122 is opened so as to supply a drying gas G to an inside of the drain pipe 110. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0104] Furthermore, the substrate processing apparatus (the substrate processing system 1) according to an embodiment further includes a second gas supply pipe 130, and a second gas supply valve 132. The second gas supply pipe 130 is connected to the supply pipe 100 on a downstream side of the supply valve 102 and an upstream side of a connection part 101 to the drain pipe 110 and supplies a drying gas G to an inside of the supply pipe 100. The second gas supply valve 132 is provided on the second gas supply pipe 130. Furthermore, in the cleaning recipe, the supply valve 102 is closed and the drain valve 111 is opened so as to draw the cleaning liquid L that is left in the nozzle 41 and simultaneously the second gas supply valve 132 is opened so as to supply a drying gas G to an inside of the supply pipe 100. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0105] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, the cleaning liquid L is a purified water (DIW) at a temperature of 20°C to 50°C. Thereby, it is

possible to execute a cleaning process for a supply pipe 100 at low cost.

[0106] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, the cleaning liquid L is a purified water (DIW) at a temperature of 50°C to 80°C. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0107] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, the cleaning liquid L is SC1 at a temperature of 20°C to 80°C. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0108] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, a mixing ratio of the cleaning liquid L is ammonia: an aqueous solution of hydrogen peroxide: water = 1: 1: 100 to 1: 1: 10. Thereby, it is possible to clean an inside of a supply pipe 100 more efficiently.

[0109] Furthermore, in the substrate processing apparatus (the substrate processing system 1) according to an embodiment, an amount of the cleaning liquid L that is supplied to an inside of the supply pipe 100 and an inside of the drain pipe 110 is 1000 (mL/min) to 1500 (mL/min). Thereby, it is possible to clean an inside of a supply pipe

100 more efficiently.

[0110] Procedure of Cleaning Process

Next, procedures of cleaning processes according to an embodiment and various types of variations thereof will be explained with reference to FIG. 17 to FIG. 20. FIG. 17 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system 1 according to an embodiment.

[0111] In a cleaning process according to an embodiment, first, a controller 18 opens a supply valve 102 and a drain valve 111 (step S101). Thereby, the controller 18 supplies a cleaning liquid L to a supply pipe 100 and a drain pipe 110 (step S102).

[0112] Then, the controller 18 closes the supply valve 102 (step S103). Additionally, herein, the controller 18 maintains the drain valve 111 in an open state thereof. Thereby, the controller 18 draws a cleaning liquid L that is left in a nozzle 41 (step S104).

[0113] Moreover, the controller 18 maintains the supply valve 102 in a closed state thereof and maintains the drain valve 111 in an open state thereof, so as to discharge a cleaning liquid L from an inside of the supply pipe 100 and an inside of the drain pipe 110 (step S105).

[0114] Finally, the controller 18 closes the drain valve 111 (step S106), so as to end a cleaning process according

to an embodiment.

[0115] FIG. 18 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system 1 according to variation 1 of an embodiment.

[0116] In a cleaning process according to variation 1, first, a controller 18 opens a supply valve 102 and a drain valve 111 (step S201). Thereby, the controller 18 supplies a cleaning liquid L to a supply pipe 100 and a drain pipe 110 (step S202).

[0117] Then, the controller 18 closes the supply valve 102 (step S203). Additionally, herein, the controller 18 maintains the drain valve 111 in an open state thereof. Thereby, the controller 18 draws a cleaning liquid L that is left in a nozzle 41 (step S204).

[0118] Finally, the controller 18 closes the drain valve 111 (step S205) so as to end a cleaning process according to variation 1.

[0119] FIG. 19 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system 1 according to variation 2 of an embodiment.

[0120] In a cleaning process according to variation 2, first, a controller 18 opens a supply valve 102 and a drain valve 111 (step S301). Thereby, the controller 18 supplies

a cleaning liquid L to a supply pipe 100 and a drain pipe 110 (step S302).

[0121] Then, the controller 18 closes the supply valve 102 (step S303). Additionally, herein, the controller 18 maintains the drain valve 111 in an open state thereof. Thereby, the controller 18 draws a cleaning liquid L that is left in a nozzle 41 (step S304).

[0122] Moreover, the controller 18 maintains the supply valve 102 in a closed state thereof and maintains the drain valve 111 in an open state thereof, so as to discharge a cleaning liquid L from an inside of the supply pipe 100 and an inside of the drain pipe 110 (step S305).

[0123] Then, the controller 18 closes the drain valve 111 (step S306). Then, the controller 18 opens a first gas supply valve 122 (step S307), and thereby, the controller 18 supplies a drying gas G to an inside of the drain pipe 110 (step S308). Then, a cleaning process according to variation 2 is ended.

[0124] FIG. 20 is a flowchart that illustrates an example of a procedure of a cleaning process that is executed by a substrate processing system 1 according to variation 3 of an embodiment.

[0125] In a cleaning process according to variation 3, first, a controller 18 opens a supply valve 102 and a drain valve 111 (step S401). Thereby, the controller 18 supplies

a cleaning liquid L to a supply pipe 100 and a drain pipe 110 (step S402).

[0126] Then, the controller 18 closes the supply valve 102 (step S403). Additionally, herein, the controller 18 maintains the drain valve 111 in an open state thereof. Thereby, the controller 18 draws a cleaning liquid L that is left in a nozzle 41 (step S404).

[0127] Moreover, the controller 18 maintains the supply valve 102 in a closed state thereof and maintains the drain valve 111 in an open state thereof, so as to discharge a cleaning liquid L from an inside of the supply pipe 100 and an inside of the drain pipe 110 (step S405).

[0128] Furthermore, the controller 18 opens a second gas supply valve 132 (step S406) in parallel with processes at steps S403 to S405 as described above, and thereby, the controller 18 supplies a drying gas G to an inside of the supply pipe 100 (step S407).

[0129] Finally, the controller 18 closes the drain valve 111 and the second gas supply valve 132 (step S408) so as to end a cleaning process according to variation 3.

[0130] A cleaning method for a substrate processing apparatus according to an embodiment includes a step that opens a supply valve 102, a step that opens a drain valve 111, and a step that cleans an inside of a drain pipe 110. The step that opens a supply valve 102 opens a supply valve

102 that is provided on a supply pipe 100 that supplies a liquid to a nozzle 41. The step that opens a drain valve 111 opens a drain valve 111 that is provided on a drain pipe 110 that is connected to the supply pipe 100 on a downstream side of the supply valve 102 and discharges a liquid inside the supply pipe 100. The step that cleans an inside of a drain pipe 110 supplies a cleaning liquid L to an inside of the supply pipe 100 and an inside of the drain pipe 110, so that an inside of the drain pipe 110 is cleaned. Thereby, it is possible to clean an inside of a supply pipe 100 efficiently.

[0131] Although an embodiment of the present disclosure has been explained above, the present disclosure is not limited to an embodiment as described above and a variety of modifications are possible without departing from an essence thereof. For example, although a cleaning process for a supply pipe 100 at an activation step immediately after a substrate processing system 1 is installed in a factory has been illustrated in an embodiment as described above, the present disclosure is not limited to such an example.

[0132] For example, a technique of the present disclosure may also be applied to a case where a cleaning process for a supply pipe 100 is executed for a purpose of regular maintenance in a case where an activation step is

completed and liquid processing for a wafer W is executed in a substrate processing system 1.

[0133] It should be considered that an embodiment(s) that is/are disclosed herein is/are not limitative but is/are illustrative in all aspects. In fact, it is possible to implement an embodiment(s) as described above in a wide variety of modes thereof. Furthermore, an embodiment(s) as described above may be omitted, substituted, and/or modified in a variety of modes thereof without departing from an appended claim(s) and an essence thereof.

[0006] According to the present disclosure, it is possible to efficiently clean an inside of a supply pipe that supplies a processing liquid to a nozzle.

[0000] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

CLAIM(S)

What is claimed is:

1. A substrate processing apparatus, comprising:

a holding unit that holds and rotates a substrate;

a nozzle that discharges a liquid to the substrate that is held by the holding unit;

a supply pipe that supplies a liquid to the nozzle;

a supply valve that is provided on the supply pipe;

a drain pipe that is connected to the supply pipe on a downstream side of the supply valve and discharges a liquid inside the supply pipe;

a drain valve that is provided on the drain pipe; and

a controller that controls each unit, wherein

the controller executes a cleaning recipe that supplies a cleaning liquid to an inside of the supply pipe and an inside of the drain pipe in a state where the supply valve and the drain valve are opened simultaneously, so that an inside of the drain pipe is cleaned.

2. The substrate processing apparatus according to claim 1, wherein,

in the cleaning recipe, a time period when the supply valve and the drain valve are opened simultaneously is 30 seconds to 120 seconds.

3. The substrate processing apparatus according to claim 1 or 2, wherein,

in the cleaning recipe, the supply valve and the drain valve are opened simultaneously to clean an inside of the drain pipe and subsequently the supply valve is closed and the drain valve is opened to draw the cleaning liquid that is left in the nozzle.

4. The substrate processing apparatus according to claim 3, wherein,

in the cleaning recipe, a time period when the supply valve is closed and the drain valve is opened is 2 seconds to 120 seconds.

5. The substrate processing apparatus according to claim 3 or 4, further comprising:

a first gas supply pipe that is connected to the drain pipe on a downstream side of the drain valve and supplies a drying gas to an inside of the drain pipe; and

a first gas supply valve that is provided on the first gas supply pipe, wherein,

in the cleaning recipe, the supply valve is closed and the drain valve is opened to draw the cleaning liquid that is left in the nozzle and subsequently the drain valve is closed and the first gas supply valve is opened to supply a

drying gas to an inside of the drain pipe.

6. The substrate processing apparatus according to any one of claims 3 to 5, further comprising:

a second gas supply pipe that is connected to the supply pipe on a downstream side of the supply valve and an upstream side of a connection part to the drain pipe and supplies a drying gas to an inside of the supply pipe; and

a second gas supply valve that is provided on the second gas supply pipe, wherein

in the cleaning recipe, the supply valve is closed and the drain valve is opened to draw the cleaning liquid that is left in the nozzle and simultaneously the second gas supply valve is opened to supply a drying gas to an inside of the supply pipe.

7. The substrate processing apparatus according to any one of claims 1 to 6, wherein

the cleaning liquid is a purified water at a temperature of 20°C to 50°C.

8. The substrate processing apparatus according to any one of claims 1 to 6, wherein

the cleaning liquid is a purified water at a temperature of 50°C to 80°C.

9. The substrate processing apparatus according to any one of claims 1 to 6, wherein

the cleaning liquid is SC1 (a mixed liquid of ammonia, an aqueous solution of hydrogen peroxide, and water) at a temperature of 20°C to 80°C.

10. The substrate processing apparatus according to claim 9, wherein

a mixing ratio of the cleaning liquid is ammonia: an aqueous solution of hydrogen peroxide: water = 1: 1: 100 to 1: 1: 10.

11. The substrate processing apparatus according to any one of claims 1 to 10, wherein

an amount of the cleaning liquid that is supplied to an inside of the supply pipe and an inside of the drain pipe is 1000 (mL/min) to 1500 (mL/min).

12. A cleaning method for a substrate processing apparatus, including:

a step that opens a supply valve that is provided on a supply pipe that supplies a liquid to a nozzle;

a step that opens a drain valve that is provided on a drain pipe that is connected to the supply pipe on a

downstream side of the supply valve and discharges a liquid inside the supply pipe; and

a step that supplies a cleaning liquid to an inside of the supply pipe and an inside of the drain pipe, so that an inside of the drain pipe is cleaned.