

DESCRIPTION

TITLE OF THE INVENTION:

SUBSTRATE PROCESSING APPARATUS, SUBSTRATE PROCESSING
5 METHOD, AND STORAGE MEDIUM

Field

[0001] The present disclosure relates to a substrate
processing apparatus, a substrate processing method, and a
10 storage medium.

Background

[0002] There has been conventionally known a technique
of processing a substrate such as a semiconductor wafer
(hereinafter also referred to as wafer) by using ozonated
15 water (see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Laid-open Patent
Publication No. 2021-190445

20 Summary

Technical Problem

[0004] The present disclosure provides a technique
capable of efficiently processing a substrate by using a
chemical liquid.

25 Solution to Problem

[0005] According to one aspect of the present
disclosure, a substrate processing apparatus includes a
processing tank, a lid body, a chemical liquid supply unit,
a pressurizing unit, and a controller. The processing tank
30 has an opening in an upper portion thereof, and immerses
and processes a substrate in a chemical liquid. The lid
body is configured to be capable of sealing the opening of
the processing tank. The chemical liquid supply unit

supplies the chemical liquid to the processing tank. The pressurizing unit pressurizes the chemical liquid on an upstream side of the chemical liquid supply unit. The controller controls each unit. The controller immerses the substrate in the chemical liquid retained in the processing tank, seals the opening of the processing tank by the lid body, and supplies the chemical liquid pressurized by the pressurizing unit to the processing tank from the chemical liquid supply unit to pressurize the chemical liquid retained in the processing tank.

Advantageous Effects of Invention

[0006] According to the present disclosure, it is possible to efficiently process a substrate by using a chemical liquid.

Brief Description of Drawings

[0007] FIG. 1 is a diagram illustrating a configuration of a substrate processing apparatus according to an embodiment.

FIG. 2 is a diagram illustrating a peripheral configuration of a lid body according to the embodiment.

FIG. 3 is a diagram illustrating a peripheral configuration of the lid body according to the embodiment.

FIG. 4 is a diagram illustrating a peripheral configuration of the lid body according to the embodiment.

FIG. 5 is a flowchart illustrating a procedure for a substrate process to be executed by the substrate processing apparatus according to the embodiment.

FIG. 6 is a diagram illustrating a configuration of the substrate processing apparatus according to a modification 1 of the embodiment.

FIG. 7 is a cross-sectional view of a processing tank illustrated in FIG. 6 that is viewed from a positive X-axis direction to a negative X-axis direction.

FIG. 8 is a diagram illustrating one example of a relationship between a wavelength (nm) of light irradiated from a light irradiation unit, with which a wafer is irradiated, and a light absorption rate(%) with respect to the wafer.

FIG. 9 is a flowchart illustrating a procedure for a substrate process to be executed by the substrate processing apparatus according to the modification 1 of the embodiment.

FIG. 10 is a diagram illustrating a configuration of the substrate processing apparatus according to a modification 2 of the embodiment.

FIG. 11 is a flowchart illustrating a procedure for a substrate process to be executed by the substrate processing apparatus according to the modification 2 of the embodiment.

Description of Embodiments

[0008] Hereinafter, modes (hereinafter referred to as "embodiments") for carrying out a substrate processing apparatus, a substrate processing method, and a storage medium according to the present disclosure will be explained in detail with reference to drawings. Note that these embodiments do not limit the present disclosure.

[0009] Furthermore, expressions of "constant", "perpendicular", "vertical", and "parallel" used in the following embodiments are not necessarily identical to "constant", "perpendicular", "vertical", and "parallel" strictly. In other words, the above-mentioned expressions may include a divergence caused by, for example, manufacturing accuracy, installation accuracy, and the like.

[0010] In the drawings referred herein, an X-axis direction, a Y-axis direction, and a Z-axis direction that

are perpendicular to each other are defined, and a rectangular coordinate system having a Z-axis positive direction as the upward vertical direction may be indicated for better understanding. Furthermore, the direction of rotation around the vertical axis may be referred to as the θ direction.

[0011] There has been known a technique of processing a substrate such as a semiconductor wafer (hereinafter also referred to as wafer) by using ozonated water. However, in the above-mentioned conventional technique, there has been room for further improvement in efficiently processing the substrate by using a chemical liquid such as ozonated water.

[0012] Thus, a technique is desired that overcomes the above-mentioned problem so as to efficiently process a substrate by using a chemical liquid.

[0013] <Configuration of Substrate Processing Apparatus>

A configuration of the substrate processing apparatus according to the embodiment will be explained with reference to FIG. 1. FIG. 1 is a diagram illustrating the configuration of the substrate processing apparatus according to the embodiment.

[0014] As illustrated in FIG. 1, a substrate processing apparatus 1 includes a processing liquid generating unit 10 and a substrate processing unit 30. The processing liquid generating unit 10 sequentially generates various kinds of processing liquids such as ozonated water (one example of chemical liquid), a rinse liquid, and a cleaning liquid. The substrate processing unit 30 executes, in a single processing tank 31, a series of substrate processes including an ozonated water process, a rinsing process, and a cleaning process with respect to a wafer W by using the various kinds of processing liquids that are sequentially

generated.

[0015] Furthermore, the substrate processing apparatus 1 includes a processing liquid supply route 21 that is provided from the processing liquid generating unit 10 to the substrate processing unit 30. The above-mentioned processing liquid supply route 21 connects a DIW supply source 22a of the processing liquid generating unit 10 with the substrate processing unit 30.

[0016] A first supply route 22, a mixer 23, and a second supply route 24 are connected in this order so as to configure the processing liquid supply route 21.

[0017] The first supply route 22 supplies, to the mixer 23, Deionized Water (DIW) that is raw material of ozonated water, DIW as a rinse liquid, and DIW that is raw material of SC1 (aqueous solution including ammonia and hydrogen peroxide) as a cleaning liquid. The first supply route 22 includes the DIW supply source 22a, a degassing module 22b, a cooling device 22c, a valve 22d, a constant-pressure valve 22e, and a flowmeter 22f in an order starting from an upstream side.

[0018] The DIW supply source 22a is, for example, a tank for storing DIW. The degassing module 22b removes a dissolved gas such as nitrogen that dissolves in DIW supplied from the DIW supply source 22a. Removing the dissolved gas included in DIW by using the above-mentioned degassing module 22b makes it possible to efficiently dissolve ozone gas in DIW.

[0019] The cooling device 22c cools DIW passing through the first supply route 22 to a predetermined temperature (for example, 10°C to 20°C). The above-mentioned cooling device 22c cools DIW thereby making it possible to efficiently dissolve ozone gas in DIW.

[0020] The constant-pressure valve 22e adjusts a flow

rate of DIW supplied to the mixer 23 based on a flow rate of DIW that is measured by the flowmeter 22f. In other words, the constant-pressure valve 22e performs feedback control based on the flow rate of DIW that is measured by the flowmeter 22f.

[0021] The mixer 23 is connected with the first supply route 22 on an upstream side thereof and is connected with the second supply route 24 on a downstream side thereof. Furthermore, an acid-based chemical liquid supply route 26 is connected with the mixer 23.

[0022] The acid-based chemical liquid supply route 26 supplies an acid-based chemical liquid such as an organic acid (citric acid, acetic acid, etc.), hydrochloric acid, and sulfuric acid to the mixer 23. According to the embodiment, in a case where an acid-based chemical liquid is supplied to DIW to adjust pH of DIW to be acidic, a concentration of ozone dissolved in DIW can be increased.

[0023] The acid-based chemical liquid supply route 26 includes an acid-based chemical liquid supply source 26a, a valve 26b, a constant-pressure valve 26c, and a flowmeter 26d in an order starting from an upstream side. The acid-based chemical liquid supply source 26a is, for example, a cabinet, a circulation line, or the like that is capable of generating an acid-based chemical liquid.

[0024] The constant-pressure valve 26c adjusts a flow rate of an acid-based chemical liquid supplied to the mixer 23 based on a flow rate of an acid-based chemical liquid that is measured by the flowmeter 26d. In other words, the constant-pressure valve 26c performs feedback control based on the flow rate of the acid-based chemical liquid that is measured by the flowmeter 26d.

[0025] An ozone gas supply route 41 is connected with the mixer 23 on a downstream side of a connection point

with the acid-based chemical liquid supply route 26.

[0026] The ozone gas supply route 41 supplies ozone gas to the mixer 23. The ozone gas supply route 41 includes an ozone gas generating unit 42 and a valve 43 in an order
5 starting from an upstream side. Note that a check valve may be provided between the valve 43 and the mixer 23.

[0027] The ozone gas generating unit 42 generates ozone gas from oxygen gas by using a well-known technique.

Oxygen gas that is raw material of ozone gas is supplied
10 from an oxygen gas supply route 44 to the ozone gas generating unit 42. The oxygen gas supply route 44 includes an oxygen gas supply source 44a, a constant-pressure valve 44b, and a valve 44c in an order starting from an upstream side. The oxygen gas supply source 44a
15 is, for example, a tank for storing oxygen gas.

[0028] Note that although not illustrated in FIG. 1, a cooling water supply unit for supplying cooling water and a cooling water discharge unit for discharging cooling water that has been used are connected with the ozone gas
20 generating unit 42.

[0029] A ammonia water supply route 51 is connected with the mixer 23 on a downstream side of a connection point with the ozone gas supply route 41.

[0030] The ammonia water supply route 51 supplies
25 ammonia water that is raw material of SC1 as a cleaning liquid to the mixer 23. The ammonia water supply route 51 includes an ammonia water supply source 51a, a valve 51b, a constant-pressure valve 51c, and a flowmeter 51d sequentially from upstream. The ammonia water supply
30 source 51a is, for example, a tank for storing ammonia water.

[0031] The constant-pressure valve 51c adjusts a flow rate of ammonia water supplied to the mixer 23 based on a

flow rate of ammonia water that is measured by the flowmeter 51d. In other words, the constant-pressure valve 51c performs feedback control based on the flow rate of ammonia water that is measured by the flowmeter 51d.

5 [0032] An aqueous hydrogen peroxide supply route 52 is connected with the mixer 23 on a downstream side of a connection point with the ammonia water supply route 51.

[0033] An aqueous hydrogen peroxide supply route 52 supplies aqueous hydrogen peroxide that is raw material of SC1 as a cleaning liquid to the mixer 23. The aqueous hydrogen peroxide supply route 52 includes an aqueous hydrogen peroxide supply source 52a, a valve 52b, a constant-pressure valve 52c, and a flowmeter 52d in an order starting from an upstream side. The aqueous hydrogen peroxide supply source 52a is, for example, a tank for storing aqueous hydrogen peroxide.

[0034] The constant-pressure valve 52c adjusts a flow rate of aqueous hydrogen peroxide supplied to the mixer 23 based on a flow rate of aqueous hydrogen peroxide that is measured by the flowmeter 52d. In other words, the constant-pressure valve 52c performs feedback control based on the flow rate of aqueous hydrogen peroxide that is measured by the flowmeter 52d.

[0035] The mixer 23 selectively mixes other chemical liquid, gas, or the like with DIW supplied from the first supply route 22 so as to sequentially generate various kinds of processing liquids. In other words, the mixer 23 is capable of mixing DIW supplied from the first supply route 22 with an acid-based chemical liquid that is supplied from the acid-based chemical liquid supply route 26 and ozonated gas supplied from the ozone gas supply route 41 so as to generate ozonated water. Furthermore, the mixer 23 is capable of mixing DIW supplied from the

first supply route 22 with ammonia water supplied from the ammonia water supply route 51 and the aqueous hydrogen peroxide that is supplied from the aqueous hydrogen peroxide supply route 52 so as to generate SC1.

5 Furthermore, the mixer 23 is also capable of causing DIW as a rinse liquid to flow down on a downstream side of the mixer 23 without mixing other chemical liquid or gas with the DIW that is supplied from the first supply route 22. The second supply route 24 is connected with the mixer 23
10 on a downstream side thereof.

[0036] The second supply route 24 is provided between the mixer 23 of the processing liquid generating unit 10 and the substrate processing unit 30 to supply the various kinds of processing liquids that are supplied from the
15 mixer 23 to first nozzles 33 of the substrate processing unit 30 that are to be mentioned later. Specifically, the second supply route 24 sequentially supplies ozonated water, DIW as a rinse liquid, and SC1 as a cleaning liquid to the first nozzles 33.

20 [0037] The second supply route 24 includes a constant-pressure valve 24a, a filter 24b, a flowmeter 24c, and a valve 24d in an order starting from an upstream side. The constant-pressure valve 24a adjusts a flow rate of a processing liquid passing through the second supply route
25 24 based on a flow rate of ozonated water that is measured by the flowmeter 24c. In other words, the constant-pressure valve 24a performs feedback control based on the flow rate of the processing liquid that is measured by the flowmeter 24c.

30 [0038] The filter 24b removes contaminants such as particles included in the various kinds of processing liquids passing through the second supply route 24.

[0039] On an upstream side of the constant-pressure

valve 24a in the second supply route 24, a third supply route 60 diverges from the second supply route 24 to be connected with second nozzles 34 of the substrate processing unit 30 that are to be mentioned later. The
5 third supply route 60 supplies ozonated water to the second nozzle 34.

[0040] The third supply route 60 includes a valve 61, a filter 62, a pump 63 (one example of pressurizing unit), and a flowmeter 64 in an order starting from an upstream
10 side. The filter 62 removes contaminants such as particles included in ozonated water passing through the third supply route 60.

[0041] The pump 63 pressurizes ozonated water passing through the third supply route 60 to a predetermined
15 pressure higher than atmospheric pressure. Pressurized ozonated water is supplied to the second nozzles 34 via the third supply route 60. As mentioned above, pressurizing ozonated water makes it possible to efficiently generate ozonated water that has a predetermined ozone
20 concentration.

[0042] This is because a molar fraction M of ozone gas that dissolves in DIW of raw material liquid is assumed to follow Henry's law represented by the following formula (1), and because according to the Henry's law, the molar
25 fraction M of dissolved ozone gas is proportional to a partial pressure P of ozone in a gas.

$$M = H^{-1} \cdot P \quad (1)$$

H: Henry's law constant

[0043] Herein, for example, the above-mentioned
30 "predetermined ozone concentration" is an ozone concentration that permits a resist film formed on the wafer W to be removed (peeled off), within the range of 500 mg/L to 1500 mg/L, for example. Furthermore, for example,

the above-mentioned "predetermined pressure" is a pressure that is able to maintain an ozone concentration of ozonated water to be a predetermined level, within the range of 0.6 MPa to 2.0 MPa, for example.

5 [0044] The substrate processing unit 30 includes a processing tank 31, a holding unit 32, the first nozzles 33 (one example of another chemical liquid supply unit), the second nozzles 34 (one example of chemical liquid supply unit), a first liquid discharge unit 35 (one example of
10 chemical liquid discharge unit), a second liquid discharge unit 36, and a lid body 37

[0045] The processing tank 31 is a box-shaped tank having an opening 31a in an upper portion thereof to sequentially store therein various kinds of processing
15 liquids. In other words, the processing tank 31 sequentially stores ozonated water, DIW as a rinse liquid, and SC1 as a cleaning liquid. The wafers W for an amount of a single lot that are arranged in an erected state are immersed in the processing liquids stored in the processing
20 tank 31.

[0046] Note that a not-illustrated liquid receiving container that surrounds the processing tank 31 is located in an outside of the processing tank 31. The liquid receiving container receives the processing liquids flowing
25 from the opening 31a of the processing tank 31.

[0047] The holding unit 32 holds the plurality of wafers W forming a lot one behind another in a line in an erected posture. The holding unit 32 is fixed to an immersion position in which the entire wafers W are immersed in the
30 processing liquids inside the processing tank 31. The holding unit 32 is capable of receiving the plurality of wafers W from a substrate transfer device for transferring the plurality of wafers W to locate them in the immersion

position.

[0048] The first nozzles 33 are located inside the processing tank 31 to supply ozonated water, DIW as a rinse liquid, and SC1 as a cleaning liquid to the processing tank 31. The first nozzles 33 extends in a direction in which the plurality of wafers W is arranged (Y-axis direction) to discharge ozonated water, DIW as a rinse liquid, and SC1 as a cleaning liquid from a plurality of discharge ports that is provided along a direction in which the plurality of wafers W is arranged.

[0049] The first nozzles 33 are connected with the second supply route 24 of the processing liquid supply route 21 to discharge ozonated water, DIW as a rinse liquid, and SC1 as a cleaning liquid that are supplied from the second supply route 24 from the plurality of discharge ports.

[0050] The first nozzles 33 are able to supply ozonated water to the processing tank 31 at a flow rate greater than that of ozonated water supplied from the second nozzles 34 to the processing tank 31. For this reason, the discharge ports of the first nozzles 33 have an opening diameter greater than that of the discharge ports of the second nozzles 34.

[0051] The second nozzles 34 are located lower than the first nozzles 33 inside the processing tank 31 to supply pressurized ozonated water to the processing tank 31. The second nozzles 34 extend along the direction in which the plurality of wafers W is arranged (Y-axis direction) to discharge pressurized ozonated water from a plurality of discharge ports that is provided along the direction in which the plurality of wafers W is arranged.

[0052] The second nozzles 34 are connected with the third supply route 60 of the processing liquid supply route

21 to discharge, from the plurality of discharge ports thereof, pressurized ozonated water that is supplied from the third supply route 60.

[0053] The first liquid discharge unit 35 discharges
5 ozonated water into a drain DR from the processing tank 31 in processing the wafer W by using pressurized ozonated water. The first liquid discharge unit 35 includes a discharge path 35a, a back pressure valve 35c, a flowmeter 35d, and a valve 35e.

10 [0054] The discharge path 35a is connected to a position that is higher than the wafer W and that is lower than the opening 31a in the processing tank 31. The discharge path 35a is provided with a pressure sensor 35b, the back pressure valve 35c, the flowmeter 35d, and the valve 35e in
15 this order starting from an upstream side relative to a connection position with the processing tank 31.

[0055] The pressure sensor 35b is provided on an upstream side of the back pressure valve 35c and the flowmeter 35d in the discharge path 35a to detect a
20 pressure of ozonated water passing through the discharge path 35a. A detection value detected by the pressure sensor 35b is output to a controller 71 to be mentioned later. The back pressure valve 35c adjusts a flow rate of ozonated water passing through the discharge path 35a based
25 on a flow rate of ozonated water that is measured by the flowmeter 35d. In other words, the back pressure valve 35c performs feedback control based on the flow rate of ozonated water that is measured by the flowmeter 35d.

[0056] In switching respective processing liquids that
30 have been used for a ozonated water process, a rinsing process, and a cleaning process with respect to the wafer W, the second liquid discharge unit 36 discharges the processing liquids into the drain DR. The second liquid

discharge unit 36 includes a discharge path 36a and a valve 36b. The discharge path 36a is connected with the bottom of the processing tank 31.

[0057] The lid body 37 is configured to be capable of
5 sealing the opening 31a of the processing tank 31. Details of the above-mentioned lid body 37 will be mentioned later.

[0058] Furthermore, the substrate processing apparatus 1
further includes a control device 70. The control device
70 controls operation of each unit of the substrate
10 processing apparatus 1. The control device 70 is a
computer, for example, and includes the controller 71 and a
storage 72.

[0059] The controller 71 is a controller. For example,
a Central Processing Unit (CPU), a Micro Processing Unit
15 (MPU), or the like executes various kinds of programs that
are recorded in a storage device in the control device 70
by using an RAM as a work area so as to realize the
controller 71. Furthermore, the controller 71 may also be
realized by using an integrated circuit such as an
20 Application Specific Integrated Circuit (ASIC) and FPGA
(Field Programmable Gate Array).

[0060] The controller 71 includes a computer-readable
storage medium. The storage medium stores the above-
mentioned programs for controlling various kinds of
25 processes that are to be executed by the substrate
processing apparatus 1. The programs may have been
recorded in the computer-readable storage medium, and may
have been installed on the storage medium of the controller
71 from another storage medium. The computer-readable
30 storage medium includes, for example, a hard disk (HD), a
flexible disk (FD), a compact disk (CD), a magneto-optical
disk (MO), a memory card, etc.

[0061] The storage 72 is realized by using a

semiconductor memory device such as a Random Access Memory (RAM) and a Flash Memory, or a storage device such as a hard disk and an optical disk.

[0062] <Peripheral Configurations of Lid Body>

5 FIGS. 2 to 4 are each a diagram illustrating a peripheral configuration of the lid body 37 according to the embodiment. FIG. 2 illustrates a state where the lid body 37 is located in a releasing position for the lid body 37 to release the opening 31a of the processing tank 31. FIG. 3 illustrates a state where the lid body 37 is located in a closing position for the lid body 37 to cover the opening 31a of the processing tank 31. FIG. 4 illustrates a state where the lid body 37 is pushed against the opening 31a of the processing tank 31.

15 [0063] As illustrated in FIGS. 2 to 4, the lid body 37 is connected with a movement mechanism 371, and the above-mentioned movement mechanism 371 permits the lid body 37 to move between the releasing position and the closing position.

20 [0064] The processing tank 31 includes an upper end 311 that protrudes higher than the opening 31a in an upper portion of a side wall. The upper end 311 is thinner than the other portions of the side wall and forms a counterbored portion that has a larger diameter than that of the opening 31a and communicates with the opening 31a in a position of the opening 31a. The above-mentioned counterbored portion of the upper end 311 accommodates the lid body 37 that is located in the closing position.

25 [0065] Furthermore, in the upper end 311, there is formed a plurality of (herein, two) insertion holes 31b passing completely through an inner wall surface and an outer wall surface of the upper end 311.

30 [0066] The substrate processing unit 30 includes a

plurality of (herein, two) locking members 38. The locking members 38 are provided to be insertable into and removable from the plurality of insertion holes 31b in the upper end 311. Movement mechanisms 381 for respectively moving the locking members 38 along a horizontal direction are connected with the locking members 38.

[0067] While the wafer W is transferred to the processing tank 31, the controller 71 causes the movement mechanism 371 to move the lid body 37 from the releasing position to the closing position. Thus, the opening 31a of the processing tank 31 is sealed by the lid body 37 (see FIG. 3).

[0068] Furthermore, the controller 71 causes the movement mechanisms 381 to move the double locking members 38 so as to respectively insert the locking members 38 into the insertion holes 31b in the upper end 311 (see FIG. 4).

[0069] The locking members 38 push the lid body 37 toward the opening 31a against an inner pressure that occurs due to pressurized ozonated water that is supplied to the processing tank 31. Thus, it is possible to maintain a state where the opening 31a of the processing tank is sealed by the lid body 37.

[0070] <Procedure for Substrate Processing>

Next, a procedure for substrate processing according to the embodiment will be explained with reference to FIG. 5. FIG. 5 is a flowchart illustrating the procedure for the substrate process to be executed by the substrate processing apparatus 1 according to the embodiment. A procedure for each process illustrated in FIG. 5 is executed in accordance with control of the controller 71.

[0071] Prior to starting a series of substrate processes illustrated in FIG. 5, no processing liquid is retained in the processing tank 31. In other words, prior to starting

the series of substrate processes, the processing tank 31 is in an empty state.

[0072] As illustrated in FIG. 5, first, ozonated water is supplied from the first nozzles 33 in the substrate processing apparatus 1 (Step S101). Specifically, the controller 71 controls the processing liquid generating unit 10 to open the valves 22d, 24d, 26b, 43, and 44c. Thus, ozonated water generated in the mixer 23 is supplied to the first nozzles 33 via the second supply route 24. Then, ozonated water is discharged from the discharge ports of the first nozzles 33 into the processing tank 31 to be retained in the processing tank 31. After predetermined time has elapsed, the controller 71 controls the processing liquid generating unit 10 to close the valves 22d, 24d, 26b, 43, and 44c. Thus, supplying ozonated water from the first nozzles 33 is stopped.

[0073] Subsequently, the wafer W is carried in the processing tank 31 in the substrate processing apparatus 1 (Step S102). Specifically, the controller 71 controls a not-illustrated substrate transfer device for transferring the wafer W to deliver the wafer W to the holding unit 32 that is located in the processing tank 31. Thus, the wafer W is brought into a state of being located in an immersion position in the processing tank 31. In other words, the wafer W is immersed in ozonated water retained in the processing tank 31.

[0074] Subsequently, the controller 71 controls the movement mechanisms 371 to seal the opening 31a of the processing tank 31 by the lid body 37 (Step S103). Then, the controller 71 controls the movement mechanisms 381 to push the lid body 37 toward the opening 31a by using the locking members 38.

[0075] Subsequently, pressurized ozonated water is

supplied from the second nozzles 34 in the substrate processing apparatus 1 (Step S104). Specifically, the controller 71 controls the processing liquid generating unit 10 to open the valves 22d, 26b, 43, 44c, and 61, and
5 also controls the pump 63 to pressurize ozonated water passing through the third supply route 60. Thus, ozonated water generated in the mixer 23 is pressurized in the third supply route 60, and the above-mentioned pressurized ozonated water is supplied to the second nozzles 34 via the
10 third supply route 60. Then, pressurized ozonated water is discharged from the discharge ports of the second nozzles 34 into the processing tank 31 so as to pressurize ozonated water retained in the processing tank 31.

[0076] As mentioned above, in the substrate processing
15 apparatus 1 according to the embodiment, ozonated water in the processing tank 31 is pressurized by pressurized ozonated water while the opening 31a of the processing tank 31 is sealed by the lid body 37. Thus, it is possible to inhibit reduction in ozone concentration of ozonated water
20 around the wafer W due to a decrease in pressure of ozonated water in the processing tank 31.

[0077] In other words, according to the embodiment, increasing a pressure of ozonated water in the processing tank 31 makes it possible to maintain a concentration of
25 ozonated water around the wafer W, so that the wafer W can be efficiently processed with ozonated water.

[0078] Subsequently, the controller 71 maintains a discharge amount of ozonated water from the first liquid discharge unit 35 to be a predetermined value (Step S105).
30 Specifically, the controller 71 opens the valve 35e, and also controls a valve opening degree of the back pressure valve 35c to be a first valve opening degree so that a measurement value of the flowmeter 35d can be maintained to

be a predetermined value. The first valve opening degree is a valve opening degree for reducing the valve opening degree of the back pressure valve 35c.

[0079] In other words, in the substrate processing apparatus 1 according to the embodiment, in pressurizing
5 ozonated water in the processing tank 31 by using pressurized ozonated water, the back pressure valve 35c is throttled so as to inhibit an increase in an discharge amount of ozonated water discharged from the first liquid
10 discharge unit 35 due to an increase in a liquid pressure of ozonated water in the processing tank 31.

[0080] Thus, a decrease in the liquid pressure of ozonated water in the processing tank 31 is inhibited, so that ozone in ozonated water becomes more difficult to
15 decompose. Thus, according to the embodiment, it is possible to efficiently process the wafer W with highly concentrated ozonated water.

[0081] Subsequently, the controller 71 judges whether or not an ozonated water process on the wafer W has ended
20 (Step S106). For example, the controller 71 may end an ozonated water process on the wafer W in a case where predetermined time has elapsed since pressurized ozonated water had been supplied to the processing tank 31 in Step S104.

25 [0082] In Step S106, in a case where an ozonated water process on the wafer W has not ended (Step S106: No), the controller 71 returns the process to Step S104.

[0083] On the other hand, in a case where it is judged that an ozonated water process on the wafer W has ended
30 (Step S106: Yes), the controller 71 stops supplying pressurized ozonated water from the second nozzles 34 (Step S107).

[0084] Subsequently, the controller 71 controls a valve

opening degree of the back pressure valve 35c to be a second valve opening degree that is greater than the first valve opening degree (Step S108). For example, the controller 71 fully opens the back pressure valve 35c.

5 Thus, ozonated water retained in the processing tank 31 is depressurized.

[0085] According to the embodiment, prior to removing the lid body 37 from the processing tank 31 that is to be performed later, ozonated water in the processing tank 31 is depressurized. Therefore, the lid body 37 can be removed in a state where an internal pressure from ozonated water in the processing tank 31 to the lid body 37 is relieved, and thus a situation where ozonated water scatters from the processing tank 31 can be avoided.

15 [0086] Subsequently, the controller 71 judges whether or not a measurement value of the pressure sensor 35b has become a prescribed value or less (Step S109). The controller 71 repeats a judgement process in Step S109 until a measurement value of the pressure sensor 35b becomes the prescribed value or less (Step S109: No).

20 [0087] On the other hand, in a case where it is judged that a measurement value of the pressure sensor 35b has become the prescribed value or less in Step S109 (Step S109: Yes), the controller 71 controls the movement mechanisms 381 to release the locking members 38 from pushing the lid body 37. Thereafter, the controller 71 controls the movement mechanism 371 to remove the lid body 37 from the opening 31a of the processing tank 31 (Step S110).

30 [0088] Thereafter, the controller 71 opens the valve 36b for a predetermined time interval to discharge ozonated water from the processing tank 31.

[0089] Subsequently, a rinsing process on the wafer W is

performed in the substrate processing apparatus 1 (Step S111). Specifically, the controller 71 opens the valves 22d and 24d. Thus, DIW as a rinsing liquid is retained in the processing tank 31, and the wafer W is immersed in DIW.

5 Thus, ozonated water is removed from the wafer W.

[0090] Thereafter, the controller 71 closes the valves 22d and 24d, and opens the valve 36b for a predetermined time interval to discharge DIW from the processing tank 31.

[0091] Subsequently, a cleaning process of the wafer W
10 is performed in the substrate processing apparatus 1 (Step S112). Specifically, the controller 71 opens the valves 22d, 24d, 51b, and 52b. Thus, SC1 as a cleaning liquid is retained in the processing tank 31, and the wafer W is immersed in SC1. Thus, an extraneous substance such as
15 particles is removed from the wafer W.

[0092] Thereafter, the controller 71 closes the valves 22d, 24d, 51b, and 52b, and opens the valve 36b for a predetermined time interval to discharge SC1 from the processing tank 31.

20 [0093] Subsequently, a rinsing process on the wafer W is performed in the substrate processing apparatus 1 (Step S113). Specifically, the controller 71 opens the valves 22d and 24d. Thus, DIW as a rinsing liquid is retained in the processing tank 31, and the wafer W is immersed in DIW.
25 Thus, SC1 is removed from the wafer W.

[0094] Subsequently, the controller 71 controls a not-illustrated substrate transfer device to carry the wafer W out of the processing tank 31 (Step S114) so as to end a series of substrate processes.

30 [0095] <Modification 1>

Next, a modification according to the embodiment will be explained with reference to FIGS. 6 to 11. FIG. 6 is a diagram illustrating a configuration of the substrate

processing apparatus 1 according to a modification 1 of the embodiment. FIG. 7 is a cross-sectional view of the processing tank 31 illustrated in FIG. 6 that is viewed from a positive X-axis direction to a negative X-axis direction. Note that the first nozzles 33 are omitted to facilitate understanding in FIG. 7.

[0096] As illustrated in FIGS. 6 and 7, the substrate processing unit 30 of the substrate processing apparatus 1 according to the modification 1 includes a holding unit 32A and a light irradiation unit 80.

[0097] The holding unit 32A holds the single wafer W in an erected position. The holding unit 32A is fixed inside the processing tank 31 to hold the wafer W in an immersion position where the entire wafer W is immersed in a processing liquid. The holding unit 32A is capable of receiving the single wafer W from a substrate transfer device (not illustrated) that transfers the single wafer W to locate it in the immersion position.

[0098] The light irradiation unit 80 is provided on the processing tank 31. The light irradiation unit 80 is a light source such as a light emitting diode (LED), for example. The light irradiation unit 80 is provided on the processing tank 31 so as to face a main surface of the wafer W. The main surface of the wafer W refers to a surface where a resist film of the wafer W is formed, for example. The light irradiation unit 80 may be provided on the processing tank 31 so as to face at least one of the main surface and a back surface that is a reverse side of the main surface of the wafer W. The light irradiation unit 80 irradiates the wafer W with light having a wavelength that permits ozonated water to be transmissive to the light.

[0099] Herein, there has conventionally been a technique

of processing a wafer by using ozonated water while irradiating the wafer with ultraviolet radiation (see Japanese Laid-open Patent Publication No. 2002-280339, for example).

5 [0100] However, in the above-mentioned technique, there is a possibility that ultraviolet irradiation with which the wafer is irradiated may be absorbed into ozonated water to raise a temperature of ozonated water. It is thought that in a case where the temperature of ozonated water
10 rises, ozone is decomposed (in other words, ozonated water is deactivated), and an ozone concentration in the ozonated water decreases.

[0101] Therefore, it has been determined that the substrate processing apparatus 1 according to the
15 modification 1 irradiates the wafer W with light having a wavelength that permits ozonated water to be transmissive to the light so as to heat the wafer W by using the light irradiation unit 80 that is provided on the processing tank 31. Thus, an increase in temperature of ozonated water can
20 be reduced as compared with a case where the wafer W is irradiated with ultraviolet radiation. Therefore, it is possible to heat the wafer W to a predetermined temperature while inhibiting reduction in ozone concentration due to a raised temperature of ozonated water. As a result, by the
25 substrate processing apparatus 1 according to the modification 1, it is possible to efficiently process the wafer W with ozonated water.

[0102] FIG. 8 is a diagram illustrating one example of a relationship between a wavelength (nm) of light irradiated
30 from the light irradiation unit 80, with which the wafer W is irradiated, and a light absorption rate(%) with respect to the wafer W. As illustrated in FIG. 8, in a case where a wavelength of light irradiated from the light irradiation

unit 80, with which the wafer W is irradiated, is 350 (nm) or more and 1100 (nm) or less, a light absorption rate with respect to the wafer W can be increased up to approximately 40(%) or more. However, in a case where a wavelength of light irradiated from the light irradiation unit 80, with which the wafer W is irradiated, is 600 (nm) or more, a light absorption rate with respect to ozonated water increases, so that a temperature of ozonated water around the wafer W rises. Therefore, from the view of selectively heating a surface of the wafer W while inhibiting an increase in temperature of ozonated water around the wafer W, a wavelength of light irradiated from the light irradiation unit 80, with which the wafer W is irradiated, is preferably 350 (nm) or more and 600 (nm) or less.

Hereinafter, light whose wavelength is 350 (nm) or more and 600 (nm) or less will be referred to as "specific wavelength light". The light irradiation unit 80 irradiates the wafer W with specific wavelength light.

[0103] Explication of FIG. 7 will be resumed. The processing tank 31 includes a light transmitting portion 31c on one of the double side walls respectively facing the main surface and the back surface of the wafer W. The light transmitting portion 31c is in contact with ozonated water and is transmissive to specific wavelength light.

The light transmitting portion 31c is formed of material that can be transmissive to specific wavelength light and that has high corrosion resistance against a processing liquid such as ozonated water. The light transmitting portion 31c has the corrosion resistance against a processing liquid such as ozonated water that is higher than those of the other portions of the processing tank 31. For example, quartz may be used as material forming the light transmitting portion 31c. The light irradiation unit

80 is located on an outer surface 31c1 of the light transmitting portion 31c that is opposite to an inner surface of the light transmitting portion 31c that is in contact with ozonated water.

5 [0104] As mentioned above, the light irradiation unit 80 is located on the outer surface 31c1 of the light transmitting portion 31c that is provided on one of the double side walls respectively facing the main surface and the back surface of the wafer W in the processing tank 31
10 so as to efficiently irradiate the main surface of the wafer W with specific wavelength light from the light irradiation unit 80. Thus, it is possible to efficiently heat the main surface of the wafer W.

[0105] FIG. 9 is a flowchart illustrating a procedure
15 for a substrate process to be executed by the substrate processing apparatus 1 according to the modification 1 of the embodiment. A procedure for each process illustrated in FIG. 9 is executed in accordance with control of the controller 71. Note that Steps S101 to S114 in FIG. 9 are
20 similar to Steps S101 to S114 in FIG. 5, so that details of explanation thereof will be omitted.

[0106] In a case where the opening 31a of the processing tank 31 is sealed with the lid body 37 (Step S103), the controller 71 controls the light irradiation unit 80 to
25 irradiate the wafer W with light having a wavelength that permits ozonated water to be transmissive to the light, namely, specific wavelength light to heat the wafer W to a predetermine temperature (Step S201).

[0107] Subsequently, pressurized ozonated water is
30 supplied from the second nozzles 34 in the substrate processing apparatus 1 (Step S104). Thus, ozonated water retained in the processing tank 31 is pressurized.

[0108] As mentioned above, according to the modification

1, while ozonated water retained in the processing tank 31 is pressurized, the wafer W is irradiated with specific wavelength light to heat the wafer W. Thus, it is possible to heat the wafer W to a predetermined temperature while inhibiting reduction in ozone concentration due to a raised temperature of ozonated water. As a result, by the substrate processing apparatus 1 according to the modification 1, it is possible to more efficiently process the wafer W with ozonated water.

10 [0109] Subsequently, the controller 71 maintains a discharge amount of ozonated water from the first liquid discharge unit 35 to be a predetermined value (Step S105).

[0110] Subsequently, the controller 71 judges whether or not an ozonated water process on the wafer W has ended (Step S106). For example, in a case where predetermined time has elapsed after starting irradiation of specific wavelength light in Step S201, the controller 71 may end an ozonated water process on the wafer W.

[0111] In a case where an ozonated water process on the wafer W has not ended in Step S106 (Step S106: No), the controller 71 returns the process to Step S201.

[0112] On the other hand, in a case where it is judged that an ozonated water process on the wafer W has ended (Step S106: Yes), the controller 71 stops irradiation of specific wavelength light (Step S202) to proceed with the process to Step S107.

[0113] <Modification 2>

In the above embodiment and the modification 1, examples have been explained, in which the wafer W is processed by ozonated water that is one example of a chemical liquid; however, the wafer W may be processed by a chemical liquid that is different from ozonated water. Thus, in a modification 2, an example is explained in which

the wafer W is processed by a chemical liquid different from ozonated water.

[0114] FIG. 10 is a diagram illustrating a configuration of the substrate processing apparatus 1 according to the modification 2 of the embodiment. As illustrated in FIG. 10, the substrate processing apparatus 1 according to the modification 2 differs from the substrate processing apparatus 1 according to the modification 1 (see FIG. 6) in that the substrate processing apparatus 1 according to the modification 2 does not have the acid-based chemical liquid supply route 26 and the ozone gas supply route 41.

Furthermore, the substrate processing apparatus 1 according to the modification 2 differs from the substrate processing apparatus 1 according to the modification 1 (see FIG. 6) in that the substrate processing apparatus 1 according to the modification 2 has a chemical liquid supply route 27.

[0115] The chemical liquid supply route 27 is connected with the mixer 23 to supply a chemical liquid different from ozonated water to the mixer 23. According to the modification 2, a chemical liquid that is different from ozonated water is simply referred to as "a chemical liquid". The above-mentioned chemical liquid is SC1 (mixed solution of ammonia and aqueous hydrogen peroxide), SC2 (mixed solution of hydrochloric acid and aqueous hydrogen peroxide), aqueous hydrogen peroxide (H_2O_2), diluted hydrofluoric acid (DHF), phosphoric acid (H_3PO_4), sulfuric acid (H_2SO_4), SPM (mixed solution of sulfuric acid and aqueous hydrogen peroxide), a mixed solution of hydrofluoric acid and hydrogen water, a mixed solution of ammonia and hydrogen water, or a mixed solution of hydrochloric acid and hydrogen water, for example.

[0116] The chemical liquid supply route 27 includes a chemical liquid supply source 27a, a valve 27b, a constant-

pressure valve 27c, and a flowmeter 27d in an order starting from an upstream side. The chemical liquid supply source 27a is a cabinet, a circulation line, or the like that is capable of generating a chemical liquid, for example.

[0117] The constant-pressure valve 27c adjusts a flow rate of a chemical liquid supplied to the mixer 23 based on a flow rate of a chemical liquid that is measured by the flowmeter 27d. In other words, the constant-pressure valve 27c performs feedback control based on a flow rate of a chemical liquid that is measured by the flowmeter 27d.

[0118] Note that in the substrate processing apparatus 1 according to the modification 2, components other than the chemical liquid supply route 27 become similar to those of the substrate processing apparatus 1 according to the modification 1 (see FIG. 6) by replacing "ozonated water" by "a chemical liquid", so that explication of the components of the substrate processing apparatus 1 according to the modification 2 will be omitted.

[0119] FIG. 11 is a flowchart illustrating a procedure for a substrate process to be executed by the substrate processing apparatus 1 according to the modification 2 of the embodiment. A procedure for each process illustrated in FIG. 11 is executed in accordance with control of the controller 71. Note that Steps S112 to S114 in FIG. 11 are similar to Steps S112 to S114 in FIG. 9, so that details of explanation thereof will be omitted.

[0120] Prior to starting a series of substrate processes illustrated in FIG. 11, no processing liquid is retained in the processing tank 31. In other words, prior to starting the series of substrate processes, the processing tank 31 is in an empty state.

[0121] As illustrated in FIG. 11, first, a chemical

liquid is supplied from the first nozzles 33 in the substrate processing apparatus 1 (Step S301).

Specifically, the controller 71 controls the processing liquid generating unit 10 to open the valve 27b. Thus, a chemical liquid is supplied to the first nozzles 33 via the second supply route 24. Then, a chemical liquid is discharged from discharge ports of the first nozzles 33 into the processing tank 31 to be retained in the processing tank 31. After predetermined time has elapsed, the controller 71 controls the processing liquid generating unit 10 to close the valve 27b. Thus, supplying a chemical liquid from the first nozzles 33 is stopped.

[0122] Subsequently, the wafer W is carried in the processing tank 31 in the substrate processing apparatus 1 (Step S302). Specifically, the controller 71 controls a not-illustrated substrate transfer device for transferring the wafer W to deliver the wafer W to a holding unit 32A that is located in the processing tank 31. Thus, the wafer W is brought into a state of being located in an immersion position in the processing tank 31. In other words, the wafer W is immersed in a chemical liquid retained in the processing tank 31.

[0123] Subsequently, the controller 71 controls the movement mechanisms 371 to seal the opening 31a of the processing tank 31 by the lid body 37 (Step S303). Then, the controller 71 controls the movement mechanisms 381 to push the lid body 37 toward the opening 31a by using the locking members 38.

[0124] Subsequently, the controller 71 controls the light irradiation unit 80 to irradiate the wafer W with light having a wavelength that permits a chemical liquid to be transmissive to the light, namely, specific wavelength light to heat the wafer W to a predetermine temperature

(Step S304).

[0125] Subsequently, a pressurized chemical liquid is supplied from the second nozzles 34 in the substrate processing apparatus 1 (Step S305). Thus, a chemical liquid retained in the processing tank 31 is pressurized.

[0126] As mentioned above, according to the modification 2, while a chemical water retained in the processing tank 31 is pressurized, the wafer W is irradiated with specific wavelength light to heat the wafer W. Thus, it is possible to heat the wafer W to a predetermined temperature while inhibiting reduction in concentration due to a raised temperature of a chemical liquid. As a result, by the substrate processing apparatus 1 according to the modification 2, it is possible to more efficiently process the wafer W with ozonated water.

[0127] Subsequently, the controller 71 maintains a discharge amount of a chemical liquid from the first liquid discharge unit 35 to be a predetermined value (Step S306).

[0128] Subsequently, the controller 71 judges whether or not a chemical liquid process on the wafer W has ended (Step S307). For example, in a case where predetermined time has elapsed after starting irradiation of specific wavelength light in Step S304, the controller 71 may end a chemical liquid process on the wafer W.

[0129] In a case where the chemical liquid process on the wafer W has not ended in Step S307 (Step S307: No), the controller 71 returns the process to Step S304.

[0130] On the other hand, in a case where it is judged that the chemical liquid process on the wafer W has ended (Step S307: Yes), the controller 71 stops irradiation of specific wavelength light (Step S308) to stop supplying a pressurized chemical liquid from the second nozzles 34 (Step S309).

[0131] Subsequently, the controller 71 controls a valve opening degree of the back pressure valve 35c to be a second valve opening degree that is greater than the first valve opening degree (Step S310). For example, the
5 controller 71 fully opens the back pressure valve 35c. Thus, a chemical liquid retained in the processing tank 31 is depressurized.

[0132] Subsequently, the controller 71 judges whether or not a measurement value of the pressure sensor 35b has
10 become a prescribed value or less (Step S311). The controller 71 repeats a judgement process in Step S311 until a measurement value of the pressure sensor 35b becomes the prescribed value or less (Step S311: No).

[0133] On the other hand, in a case where it is judged
15 that a measurement value of the pressure sensor 35b has become the prescribed value or less in Step S311 (Step S311: Yes), the controller 71 controls the movement mechanisms 381 to release the locking members 38 from pushing the lid body 37. Thereafter, the controller 71
20 controls the movement mechanism 371 to remove the lid body 37 from the opening 31a of the processing tank 31 (Step S312).

[0134] Thereafter, the controller 71 opens the valve 36b for a predetermined time interval to discharge a chemical
25 liquid from the processing tank 31.

[0135] Subsequently, a rinsing process on the wafer W is performed in the substrate processing apparatus 1 (Step S313). Specifically, the controller 71 opens the valves 22d and 24d. Thus, DIW as a rinsing liquid is retained in
30 the processing tank 31, and the wafer W is immersed in DIW. Thus, a chemical liquid is removed from the wafer W.

[0136] Thereafter, the controller 71 closes the valves 22d and 24d, and opens the valve 36d for a predetermined

time interval to discharge DIW from the processing tank 31. Thereafter, the controller 71 proceeds with the process to Step S107.

[0137] As described above, a substrate processing apparatus according to the embodiment (as one example, substrate processing apparatus 1) includes a processing tank (as one example, processing tank 31), a lid body (as one example, lid body 37), a chemical liquid supply unit (as one example, second nozzle 34), a pressurizing unit (as one example, pump 63), and a controller (as one example, controller 71). The processing tank has an opening (as one example, opening 31a) in an upper portion thereof, and immerses and processes a substrate (as one example, wafer W) in a chemical liquid. The lid body is configured to be capable of sealing the opening of the processing tank. The chemical liquid supply unit supplies the chemical liquid to the processing tank. The pressurizing unit pressurizes the chemical liquid on an upstream side of the chemical liquid supply unit. The controller controls each unit. The controller immerses the substrate in the chemical liquid retained in the processing tank, seals the opening of the processing tank by the lid body, and supplies the chemical liquid pressurized by the pressurizing unit to the processing tank from the chemical liquid supply unit to pressurize the chemical liquid retained in the processing tank. Thus, it is possible to efficiently process the substrate with the chemical liquid.

[0138] Furthermore, the substrate processing apparatus according to the embodiment may include a chemical liquid discharge unit (as one example, first liquid discharge unit 35) that discharges the chemical liquid from the processing tank. In supplying the chemical liquid pressurized by the pressurizing unit to the processing tank from the chemical

liquid supply unit, the controller may maintain a discharge amount of the chemical liquid discharged from the chemical liquid discharge unit to be a predetermined value. Thus, it is possible to efficiently process the wafer W with the chemical liquid.

[0139] Furthermore, the chemical liquid discharge unit may include a discharge path (as one example, discharge path 35a) connected to a position that is higher than the substrate and that is lower than the opening in the processing tank, and a flowmeter (as one example, flowmeter 35d) and a back pressure valve (as one example, back pressure valve 35c) that are provided in the discharge path. The controller may control a valve opening degree of the back pressure valve to be a first valve opening degree such that a measurement value of the flowmeter is maintained to be a predetermined value. Thus, it is possible to efficiently process the wafer W with the chemical liquid.

[0140] Furthermore, the controller may stop supplying the pressurized chemical liquid from the chemical liquid supply unit after processing of the substrate with the chemical liquid has ended in the processing tank, and thereafter, may control the valve opening degree of the back pressure valve to be a second valve opening degree to depressurize the chemical liquid retained in the processing tank, the second valve opening degree being greater than the first valve opening degree. Thus, it is possible to avoid a situation where the chemical liquid scatters from the processing tank.

[0141] Furthermore, the chemical liquid discharge unit may include a pressure sensor (as one example, pressure sensor 35b) provided on an upstream side of the flowmeter and the back pressure valve in the discharge path. In a

case where a detection value of the pressure sensor is a prescribed value or less, the controller may remove the lid body from the opening of the processing tank. Thus, it is possible to avoid a situation where the chemical liquid
5 scatters from the processing tank.

[0142] Furthermore, the substrate processing apparatus according to the embodiment may include another chemical liquid supply unit that supplies a chemical liquid to the processing tank at a flow rate greater than a flow rate of
10 the chemical liquid supplied to the processing tank from the chemical liquid supply unit. Prior to starting processing of the substrate with the chemical liquid in the processing tank, the controller may supply the chemical liquid to the processing tank from the other chemical
15 liquid supply unit to retain the chemical liquid in the processing tank. Thus, it is possible to rapidly retain the chemical liquid in the processing tank.

[0143] Furthermore, the substrate processing apparatus according to the embodiment may further include a locking
20 member (as one example, locking member 38) provided to be insertable into and removable from an insertion hole formed on an upper side of the opening in a side wall of the processing tank to push the lid body toward the opening. Thus, it is possible to maintain a state where the opening
25 of the processing tank is sealed by the lid body.

[0144] Furthermore, the substrate processing apparatus according to the embodiment may further include a light irradiation unit (as one example, light irradiation unit
80) provided on the processing tank, and irradiates the
30 substrate with light having a wavelength that permits the chemical liquid to be transmissive to the light. While the chemical liquid retained in the processing tank is pressurized, the controller may irradiate the substrate

with the light having the wavelength that permits the chemical liquid to be transmissive to the light to heat the substrate by using the light irradiation unit. Thus, it is possible to efficiently process the wafer W with the
5 chemical liquid.

[0145] Furthermore, the wavelength of the light may be 350 (nm) or more and 600 (nm) or less. Thus, it is possible to selectively heat a surface of the substrate while inhibiting an increase in temperature of the chemical
10 liquid around the substrate.

[0146] Furthermore, the processing tank may include a light transmitting portion (as one example, light transmitting portion 31c) on at least one of double side walls respectively facing a main surface and a back surface
15 that is a reverse side of the main surface of the substrate, the light transmitting portion being in contact with the chemical liquid and being transmissive to the light. The light irradiation unit may be located on an outer surface (as one example, outer surface 31c1) of the
20 light transmitting portion that is opposite to an inner surface of the light transmitting portion that is in contact with the chemical liquid. Thus, it is possible to efficiently heat the main surface of the substrate.

[0147] Furthermore, the chemical liquid may be ozonated
25 water, SC1 (mixed solution of ammonia and aqueous hydrogen peroxide), SC2 (mixed solution of hydrochloric acid and aqueous hydrogen peroxide), aqueous hydrogen peroxide (H_2O_2), diluted hydrofluoric acid (DHF), phosphoric acid (H_3PO_4), sulfuric acid (H_2SO_4), SPM (mixed solution of
30 sulfuric acid and aqueous hydrogen peroxide), a mixed solution of hydrofluoric acid and hydrogen water, a mixed solution of ammonia and hydrogen water, or a mixed solution of hydrochloric acid and hydrogen water. Thus, it is

possible to efficiently process the wafer W with the chemical liquid.

[0148] The embodiments disclosed this time are to be considered as illustrative in all points and not

5 restrictive. Indeed, the above embodiments may be implemented in various forms. In addition, the above-described embodiments may be omitted, replaced, or modified in various forms without departing from the scope and spirit of the appended claims.

10 Reference Signs List

[0149] 1 Substrate processing apparatus

30 Substrate processing unit

31 Processing tank

31a Opening 31a

15 31b Insertion hole

31c Light transmitting portion

31a1 Outer surface

33 First nozzle

34 Second nozzle

20 35 First liquid discharge unit

35a Discharge path

35b Pressure sensor

35c Back pressure valve 35c

35d Flowmeter

25 37 Lid body

38 Locking members

63 Pump

71 Controller

80 Light irradiation unit

30 W Wafer

CLAIMS

Claim 1. A substrate processing apparatus comprising:

a processing tank having an opening in an upper
portion thereof that immerses and processes a substrate in
5 a chemical liquid;

a lid body configured to be capable of sealing the
opening of the processing tank;

a chemical liquid supply unit that supplies the
chemical liquid to the processing tank;

10 a pressurizing unit that pressurizes the chemical
liquid on an upstream side of the chemical liquid supply
unit; and

a controller that controls each unit, wherein
the controller is further configured to:

15 immerse the substrate in the chemical liquid
retained in the processing tank;

seal the opening of the processing tank by the
lid body; and

supply the chemical liquid pressurized by the
20 pressurizing unit to the processing tank from the chemical
liquid supply unit to pressurize the chemical liquid
retained in the processing tank.

Claim 2. The substrate processing apparatus according to
25 claim 1, further comprising:

a chemical liquid discharge unit that discharges the
chemical liquid from the processing tank, wherein

the controller is further configured to:

in supplying the chemical liquid pressurized by
30 the pressurizing unit to the processing tank from the
chemical liquid supply unit, maintain a discharge amount of
the chemical liquid discharged from the chemical liquid
discharge unit to be a predetermined value.

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

the chemical liquid discharge unit includes:

5 a discharge path connected to a position that is higher than the substrate and that is lower than the opening in the processing tank; and

a flowmeter and a back pressure valve that are provided in the discharge path, wherein

10 the controller is further configured to:

control a valve opening degree of the back pressure valve to be a first valve opening degree such that a measurement value of the flowmeter is maintained to be a predetermined value.

15

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

the controller is further configured to:

20 stop supplying the pressurized chemical liquid from the chemical liquid supply unit after processing of the substrate with the chemical liquid has ended in the processing tank; and thereafter

25 control the valve opening degree of the back pressure valve to be a second valve opening degree to depressurize the chemical liquid retained in the processing tank, the second valve opening degree being greater than the first valve opening degree.

30 Claim 5. The substrate processing apparatus according to claim 4, wherein

the chemical liquid discharge unit includes a pressure sensor provided on an upstream side of the flowmeter and the back pressure valve in the discharge path, and

the controller is further configured to:

in a case where a detection value of the pressure sensor is a prescribed value or less, remove the lid body from the opening of the processing tank.

5

Claim 6. The substrate processing apparatus according to claim 1, further comprising:

another chemical liquid supply unit that supplies a chemical liquid to the processing tank at a flow rate greater than a flow rate of the chemical liquid supplied to the processing tank from the chemical liquid supply unit, wherein

10

the controller is further configured to:

prior to starting processing of the substrate with the chemical liquid in the processing tank, supply the chemical liquid to the processing tank from the other chemical liquid supply unit to retain the chemical liquid in the processing tank.

15

Claim 7. The substrate processing apparatus according to claim 1, further comprising:

a locking member provided to be insertable into and removable from an insertion hole formed on an upper side of the opening in a side wall of the processing tank to push the lid body toward the opening.

20

Claim 8. The substrate processing apparatus according to claim 1, further comprising:

a light irradiation unit provided on the processing tank, and irradiates the substrate with light having a wavelength that permits the chemical liquid to be transmissive to the light, wherein

30

the controller is further configured to:

while the chemical liquid retained in the processing tank is pressurized, irradiate the substrate with the light having the wavelength that permits the chemical liquid to be transmissive to the light to heat the substrate by using the light irradiation unit.

Claim 9. The substrate processing apparatus according to claim 8, wherein
the wavelength of the light is 350 (nm) or more and 600 (nm) or less.

Claim 10. The substrate processing apparatus according to claim 8, wherein
the processing tank includes a light transmitting portion on at least one of double side walls respectively facing a main surface and a back surface that is a reverse side of the main surface of the substrate, the light transmitting portion being in contact with the chemical liquid and being transmissive to the light, and
the light irradiation unit is located on an outer surface of the light transmitting portion that is opposite to an inner surface of the light transmitting portion that is in contact with the chemical liquid.

Claim 11. The substrate processing apparatus according to any one of claims 1 to 10, wherein
the chemical liquid is ozonated water, SC1 (mixed solution of ammonia and aqueous hydrogen peroxide), SC2 (mixed solution of hydrochloric acid and aqueous hydrogen peroxide), aqueous hydrogen peroxide (H_2O_2), diluted hydrofluoric acid (DHF), phosphoric acid (H_3PO_4), sulfuric acid (H_2SO_4), SPM (mixed solution of sulfuric acid and aqueous hydrogen peroxide), a mixed solution of

hydrofluoric acid and hydrogen water, a mixed solution of ammonia and hydrogen water, or a mixed solution of hydrochloric acid and hydrogen water.

5 Claim 12. A substrate processing method to be executed by
using a substrate processing apparatus comprising: a
processing tank having an opening in an upper portion
thereof that immerses and processes a substrate in a
chemical liquid; a lid body configured to be capable of
10 sealing the opening of the processing tank; a chemical
liquid supply unit that supplies the chemical liquid to the
processing tank; and a pressurizing unit that pressurizes
the chemical liquid on an upstream side of the chemical
liquid supply unit, the substrate processing method
15 comprising:
immersed the substrate in the chemical liquid
retained in the processing tank;
sealing the opening of the processing tank by the lid
body; and
20 supplying the chemical liquid pressurized by the
pressurizing unit to the processing tank from the chemical
liquid supply unit to pressurize the chemical liquid
retained in the processing tank.

25 Claim 13. A computer-readable storage medium to be read by
using a substrate processing apparatus comprising: a
processing tank having an opening in an upper portion
thereof that immerses and processes a substrate in a
chemical liquid; a lid body configured to be capable of
30 sealing the opening of the processing tank; a chemical
liquid supply unit that supplies the chemical liquid to the
processing tank; and a pressurizing unit that pressurizes
the chemical liquid on an upstream side of the chemical

liquid supply unit, the computer-readable storage medium non-temporarily storing therein a program for the computer to realize a process comprising:

- immersing the substrate in the chemical liquid
- 5 retained in the processing tank;
- sealing the opening of the processing tank by the lid body; and
- supplying the chemical liquid pressurized by the pressurizing unit to the processing tank from the chemical
- 10 liquid supply unit to pressurize the chemical liquid retained in the processing tank.