

GAS INTAKE SYSTEM FOR SEMICONDUCTOR PROCESS DEVICE, SEMICONDUCTOR PROCESS DEVICE, AND GAS INTAKE METHOD

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TECHNICAL FIELD

[0001] The present disclosure belongs to the field of semiconductor technology, and particularly relates to a gas intake system for a semiconductor process device, a semiconductor process device, and a gas intake method.

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BACKGROUND

[0002] With the rapid development of semiconductor process devices and semiconductor processing technology, metal etching is more and more widely applied in the semiconductor industry. After a wafer is subjected to a metal etching process, a surface of the wafer is prone to produce by-products with a process gas (e.g., chlorine), and
15 chlorine remaining on the wafer is also prone to corrode metal (e.g., aluminum) in the wafer. Therefore, the wafer after being subjected to the metal etching process needs to be processed with a gas intake system of a photoresist removing device before being sent to a next process.

[0003] The process gases commonly used by the gas intake system of the photoresist removing device include oxygen, water vapor, nitrogen and the like; and under the action
20 of high temperature and microwave inside a cavity of the gas intake system of the photoresist removing device, residual photoresist and the by-products on the surface of the wafer can be removed by oxygen, with volatilizable carbon dioxide and carbon monoxide formed, and the water vapor can be combined with chlorine in the by-products
25 to form hydrogen chloride with better volatility, thereby taking the residual chlorine away. When a photoresist removing process is performed, if the intake flow of the water vapor is unstable, the gas intake system of the photoresist removing device is prone to produce a poor dechlorination effect, and a photoresist removing rate is also reduced, resulting in a problem of residual photoresist on the wafer. Therefore, improving intake

stability of the water vapor is one of the key technologies of the semiconductor process devices such as the gas intake system of the photoresist removing device.

SUMMARY

5 [0004] The embodiments of the present disclosure aim to provide a gas intake system for a semiconductor process device, a semiconductor process device, and a gas intake method, which can improve intake stability of water vapor.

[0005] In order to at least solve the above technical problem, the present disclosure is implemented as follows.

10 [0006] In a first aspect, the present disclosure provides a gas intake system for a semiconductor process device, including a water storage tank, a gas storage tank, a water vapor conveying pipeline, and a gas supply pipeline, the water storage tank is provided with a water inlet port capable of being opened and closed, and a first heating device is disposed on the water storage tank,

15 two ends of the water vapor conveying pipeline are respectively in communication with a gas outlet of the water storage tank and a gas inlet of the gas storage tank, and the gas storage tank is in on-off communication with a process chamber of the semiconductor process device through the gas supply pipeline, and

in a case where one of the water inlet port and the water vapor conveying pipeline is in
20 an on state, the other is in an off state.

[0007] In a second aspect, the present disclosure provides a semiconductor process device, including a process chamber and the gas intake system described above, and the gas intake system is in on-off communication with the process chamber.

25 [0008] In a third aspect, the present disclosure provides a gas intake method applied to the gas intake system described above, including:

introducing liquid water into the water storage tank until a water storage amount in the water storage tank reaches a preset water storage amount;

heating the liquid water to a preset temperature, controlling the water vapor conveying pipeline to be in an on state, and controlling the water inlet port to be in an off state;

30 when a pressure in the gas storage tank reaches a preset pressure, controlling the gas supply pipeline to be in an on state, and controlling the water vapor conveying pipeline to be in an off state;

when the water storage amount in the water storage tank is less than a replenishment water storage amount, controlling the water vapor conveying pipeline to be in an off state, and controlling the water inlet port to be in an on state; and

when the pressure in the gas storage tank is lower than a replenishment pressure, controlling the water inlet port to be in an off state, and controlling the water vapor conveying pipeline to be in an on state.

[0009] In the embodiments of the present disclosure, the gas intake system for the semiconductor process device includes the water storage tank and the gas storage tank.

When the gas intake system is in use, the water inlet port of the water storage tank may

be connected to an external water inlet pipeline, so that the liquid water can be introduced into the water storage tank; when the liquid water in the water storage tank reaches the preset water storage amount, the water inlet port and the water vapor conveying pipeline are controlled to be in an off state, and the first heating device is then

turned on to heat the liquid water in the water storage tank to the preset temperature, at this time, water vapor meeting process requirements can be generated in the water storage tank. Then, the water vapor conveying pipeline may be opened and the gas supply pipeline is controlled to be in an off state, so as to allow the water vapor in the water storage tank to enter the gas storage tank. When the pressure in the gas storage tank reaches the preset pressure, the gas supply pipeline is controlled to be in an on state, so that the water vapor can enter the process chamber to participate in a process.

[0010] In the embodiments of the present disclosure, in a case where one of the water inlet port and the water vapor conveying pipeline is in an on state, the other is in an off state; that is, the water inlet port and the water vapor conveying pipeline cannot be opened at the same time, that is: when the water storage amount in the water storage tank

is less than the replenishment water storage amount, the water vapor conveying pipeline is controlled to be in an off state, and the water inlet port is opened; and when the pressure in the gas storage tank is lower than the replenishment pressure, the water inlet port is closed, and the water vapor conveying pipeline is opened. If the water storage tank and the gas storage tank are opened at the same time, the liquid water at room temperature may reduce a temperature of the water storage tank when entering the water storage tank in a process of replenishing the water storage tank with the liquid water, such that condensation of part of the water vapor in the water storage tank is caused, and a concentration of the water vapor is reduced, which may result in unstable flow of the

water vapor in the water storage tank when entering the gas storage, and further cause unstable flow of the water vapor in the gas storage tank when entering the process chamber. According to the embodiments of the present disclosure, the water inlet port and the water vapor conveying pipeline are not opened at the same time, so that the water vapor with the unstable flow generated while replenishing the water storage tank with the liquid water can be prevented from entering the gas storage tank, thereby preventing the water vapor with the unstable flow from entering the process chamber.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. 1 is a schematic structural diagram of a gas intake system according to an embodiment of the present disclosure;

[0012] FIG. 2 is a partial sectional view of a gas intake system according to an embodiment of the present disclosure;

[0013] FIG. 3 is a flowchart illustrating a gas intake method according to an embodiment of the present disclosure;

[0014] FIG. 4 is another flowchart illustrating a gas intake method according to an embodiment of the present disclosure;

[0015] FIG. 5 is a flowchart illustrating a gas tank initialization step according to an embodiment of the present disclosure; and

[0016] FIG. 6 is a block diagram of a semiconductor process device according to an embodiment of the present disclosure.

[0017] Description of reference numerals:

100-water storage tank, 110-liquid level detection device, 200-gas storage tank, 210-second heating device, 220-pressure detection device, 230-second temperature detection element, 240-first over-temperature switch, 250-second over-temperature switch, 260-first heating device, 300-water vapor conveying pipeline, 310-fifth on-off valve, 400-gas supply pipeline, 410-flow control device, 420-first on-off valve, 430-second on-off valve, 500-process chamber, 600-suction pipeline, 610-third on-off valve, 620-first one-way valve, 700-water inlet pipeline, 710-fourth on-off valve, 720-flow detection device, 730-ninth on-off valve, 800-drainage pipeline, 810-sixth on-off valve, 910-gas mixing pipeline, 911-seventh on-off valve, 920-purging pipeline, 921-eighth on-off valve, 922-second one-way valve, 930-machine main body,

931-processing module, 932-communication module, 933-analog input module, 934-digital input module, 935-digital output module, 936-temperature control module, 937-power module, 938-machine power box, 940-solenoid valve set.

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DETAIL DESCRIPTION OF EMBODIMENTS

[0018] The technical solutions provided in the embodiments of the present disclosure are clearly and thoroughly described below with reference to the drawings for the embodiments of the present disclosure. Apparently, the embodiments described herein are just some embodiments of the present disclosure, and do not cover all embodiments.

10 All other embodiments derived by those of ordinary skill in the art from the embodiments described herein without inventive work fall within the scope of the present disclosure.

[0019] The terms “first”, “second” and the like in the description and the claims of the present disclosure are used for distinguishing between similar objects, but not necessarily for describing a particular order or a chronological order. It should be understood that the data such used may be interchanged under appropriate circumstances, so as to allow the embodiments of the present disclosure to be implemented in an order other than those illustrated or described herein; and the objects distinguished by the terms “first”, “second” and the like generally belong to one kind, and the number of the objects is not limited, for example, the number of a first object may be one or more. In addition, the term “and/or” in the description and the claims indicates at least one of the objects connected by the term “and/or”, and the forward slash “/” generally indicates that the object before “/” and the object after “/” are in an “or” relationship.

25 [0020] With reference to the drawings, the gas intake system for the semiconductor process device, the semiconductor process device, and the gas intake method are described in detail below in conjunction with specific embodiments and application scenarios.

[0021] As shown in FIG. 1 to FIG. 2, an embodiment of the present disclosure discloses a gas intake system for a semiconductor process device, including a water storage tank 100, a gas storage tank 200, a water vapor conveying pipeline 300, and a gas supply pipeline 400, the water storage tank 100 is provided with a water inlet port capable of being opened and closed, a first heating device 260 is disposed on the water storage tank

100, two ends of the water vapor conveying pipeline 300 are respectively in on-off communication with a gas outlet of the water storage tank 100 and a gas inlet of the gas storage tank 200, and a gas outlet of the gas storage tank 200 is in on-off communication with a process chamber 500 of the semiconductor process device through the gas supply pipeline 400; and when one of the water inlet port and the water vapor conveying pipeline 300 is in an on state, the other is in an off state.

[0022] In the embodiment of the present disclosure, the gas intake system for the semiconductor process device includes the water storage tank 100 and the gas storage tank 200. When the gas intake system is in use, the water inlet port of the water storage tank 100 may be connected to an external water inlet pipeline 700, so that liquid water can be introduced into the water storage tank 100 through the water inlet pipeline 700; when the liquid water in the water storage tank 100 reaches a preset water storage amount, the water inlet port and the water vapor conveying pipeline 300 are controlled to be in an off state, and the first heating device 260 is then turned on to heat the liquid water in the water storage tank 100 to a preset temperature, at this time, water vapor meeting process requirements can be generated in the water storage tank 100. Then, the water vapor conveying pipeline 300 may be opened and the gas supply pipeline 400 is controlled to be in an off state, so as to allow the water vapor in the water storage tank 100 to enter the gas storage tank 200. When a pressure in the gas storage tank 200 reaches a preset pressure, the gas supply pipeline 400 is controlled to be in an on state, so that the water vapor can enter the process chamber 500 to participate in a process.

[0023] Optionally, in the embodiment of the present disclosure, both the water inlet port and the water vapor conveying pipeline 300 may be in an off state during a process. In a case where one of the water inlet port and the water vapor conveying pipeline 300 is in an on state, the other is in an off state; that is, the water inlet port and the water vapor conveying pipeline 300 cannot be opened at the same time, that is: when the water storage amount in the water storage tank 100 is less than a replenishment water storage amount, the water vapor conveying pipeline 300 is controlled to be in the off state, and the water inlet port is opened; and when the pressure in the gas storage tank 200 is lower than a replenishment pressure, the water inlet port is closed, and the water vapor conveying pipeline 300 is opened. If the water storage tank 100 and the gas storage tank 200 are opened at the same time, the liquid water at room temperature may reduce a temperature of the water storage tank 100 when entering the water storage tank 100 in a

process of replenishing the water storage tank 100 with the liquid water, such that condensation of part of the water vapor in the water storage tank 100 is caused, and a concentration of the water vapor is reduced, which may result in unstable flow of the water vapor in the water storage tank 100 when entering the gas storage tank 200, and further cause unstable flow of the water vapor in the gas storage tank 200 when entering the process chamber 500. According to the embodiment of the present disclosure, the water inlet port and the water vapor conveying pipeline 300 are not opened at the same time, so that the water vapor with the unstable flow generated while replenishing the water storage tank 100 with the liquid water can be prevented from entering the gas storage tank 200, thereby preventing the water vapor with the unstable flow from entering the process chamber 500.

[0024] Optionally, the water vapor conveying pipeline 300 may be provided with a fifth on-off valve 310 or other devices with a function of opening and closing a pipeline. For example, a cut-off plate is slidably disposed in the water vapor conveying pipeline 300, and opening and closing of the water vapor conveying pipeline are controlled by adjusting a position of the cut-off plate, so as to allow the two ends of the water vapor conveying pipeline 300 to be in on-off communication with the gas outlet of the water storage tank 100 and the gas inlet of the gas storage tank 200 respectively.

[0025] In an alternative embodiment, the gas supply pipeline 400 is provided with a flow control device 410, a first on-off valve 420, and a second on-off valve 430, the flow control device 410 is located downstream of the first on-off valve 420, and the second on-off valve 430 is located downstream of the flow control device 410. During idle time between processes, the second on-off valve 430 and the flow control device 410 need to be closed, but if the first on-off valve 420 is not provided, the flow control device 410 cannot be completely closed, that is, the water vapor in the gas storage tank 200 may leak to a first pipe section of the gas supply pipeline 400 which is between the second on-off valve 430 and the flow control device 410 through the flow control device 410, and a pressure in the first pipe section may be continuously increased; and when the second on-off valve 430 and the flow control device 410 are opened for a next process, the water vapor with a high pressure stored in the first pipe section may directly enter the process chamber 500, resulting in an instant increase of a pressure in the process chamber 500. Thus, a gas intake ratio of the water vapor to other process gases is prone to be uncontrollable, a process result may be affected, and a false alarm of excessive

pressure of the process chamber 500 may be even triggered to cause equipment downtime. Therefore, in the embodiment of the present disclosure, the first on-off valve 420 is disposed upstream of the flow control device 410, and the water vapor can be completely cut off after the first on-off valve 420 is closed during the idle time between the processes, so as to prevent the water vapor from leaking out of the gas storage tank 200 to the first pipe section of the gas supply pipeline 400 between the second on-off valve 430 and the flow control device 410, thereby avoiding the above problem. Optionally, the flow control device 410 may be a mass flow controller (MFC) or other devices capable of controlling the flow. The first on-off valve 420, the second on-off valve 430, and a third on-off valve 610, a fourth on-off valve 710, a fifth on-off valve 310, a sixth on-off valve 810, a seventh on-off valve 911, and an eighth on-off valve 921 described below may be valves capable of opening and closing a pipeline, such as ball valves, gate valves, cut-off valves, and butterfly valves.

[0026] Optionally, the gas intake system further includes a gas mixing pipeline 910, a first end of the gas mixing pipeline 910 is in on-off communication with the gas supply pipeline 400, and is located downstream of the second on-off valve 430. A process gas such as oxygen or nitrogen may be introduced into the gas supply pipeline 400 through the gas mixing pipeline 910, and the water vapor and the process gas form mixed water vapor and then enter the process chamber 500. Further, the gas mixing pipeline 910 is provided with the seventh on-off valve 911.

[0027] In an alternative embodiment, the gas intake system further includes a suction pipeline 600, a first end of the suction pipeline 600 is in on-off communication with the gas supply pipeline 400, and is located between the flow control device 410 and the second on-off valve 430. In the embodiment of the present disclosure, the suction pipeline 600 is provided, and when the gas intake system is in use, a second end of the suction pipeline 600 may be communicated with a negative pressure device or a space with a negative pressure. During the idle time between the processes, the first on-off valve 420 and the second on-off valve 430 need to be closed, but after the two on-off valves are closed, it is possible that part of the water vapor still remains in a second pipe section of the gas supply pipeline 400 which is between the first on-off valve 420 and the second on-off valve 430, and the residual water vapor in the second pipe section may be sucked out after the suction pipeline 600 is opened, so as to avoid the problem that the pressure in the process chamber 500 is instantly increased in a next process due to the

residual water vapor. In addition, the air in the water storage tank 100 may be sucked out through the suction pipeline 600, so as to avoid the problem that a water storage amount in the water storage tank 100 cannot meet a requirement for a long time in the process of introducing the liquid water into the water storage tank 100 because the liquid water cannot be introduced into the water storage tank 100 after the water storage amount in the water storage tank 100 reaches a certain amount due to an increase in the pressure in the water storage tank 100 caused by the introduction of the liquid water into the water storage tank 100. In addition, the air in the gas storage tank 200 may be sucked out through the suction pipeline 600, so that on the one hand, the pressure in the gas storage tank 200 can be reduced, and the water vapor generated in the water storage tank 100 can enter the gas storage tank 200; and on the other hand, the air in the gas storage tank 200 can be sucked out, and purity of the water vapor can be ensured. Optionally, the suction pipeline 600 may be provided with the third on-off valve 610. Certainly, other devices with a function of opening and closing a pipeline may be disposed on the suction pipeline 600, so as to allow the first end of the suction pipeline 600 to be in on-off communication with the gas supply pipeline 400. Further, the suction pipeline 600 is further provided with a first one-way valve 620, and a conduction direction of the first one-way valve 620 is a direction extending from the first end of the suction pipeline 600 to the second end of the suction pipeline 600, so as to avoid the problem that the gas in the suction pipeline 600 reversely flows into the gas supply pipeline 400 to pollute the gas supply pipeline 400 when the suction pipeline 600 is abnormal.

[0028] In an alternative embodiment, the gas intake system further includes a water inlet pipeline 700 in on-off communication with the water inlet port, the water inlet pipeline 700 is provided with a flow detection device 720, the water storage tank 100 is provided with a liquid level detection device 110, the flow detection device 720 and the liquid level detection device 110 are both configured to acquire the water storage amount in the water storage tank 100. Certainly, in practical applications, the flow detection device 720 may be also configured to acquire other related parameters by detecting water intake flow of the water storage tank 100, and the liquid level detection device 110 may be also configured to acquire other related parameters by detecting a liquid level in the water storage tank 100, but the present disclosure is not limited thereto. Exemplarily, the flow detection device 720 is configured to detect the water intake flow of the water storage tank 100, and may acquire the water storage amount in the water storage tank 100 based

on the water intake flow and water intake time; and the liquid level detection device 110 is configured to detect the liquid level in the water storage tank 100, and may acquire the water storage amount in the water storage tank 100 based on a height of the liquid level in the water storage tank 100. When the gas intake system is in use, the water storage amount acquired by the flow detection device 720 and the water storage amount acquired by the liquid level detection device 110 may be used for mutual check, so as to improve accuracy of determination of the water storage amount; and in addition, whether the flow detection device 720 and the liquid level detection device 110 are in a normal state may be determined based on a parameter detected by the flow detection device 720 and a parameter detected by the liquid level detection device 110. A determination process may be as follows: when the water supply from the plant is normal and the water storage tank 100 is being replenished, if the flow detection device 720 detects that the water intake flow is stable, but the liquid level detection device 110 detects that the liquid level in the water storage tank 100 is not changed, at this time, the liquid level detection device 110 may be in an abnormal state; and when the water supply from the plant is abnormal and the flow detection device 720 detects that the water intake flow is zero, if the liquid level detection device 110 detects that the liquid level in the water storage tank 100 still gradually rises, at this time, the liquid level detection device 110 may be in an abnormal state. Optionally, the fourth on-off valve 710 or other devices with a function of opening and closing a pipeline may be disposed on the water inlet pipeline 700, so as to enable the water inlet pipeline 700 to be in on-off communication with the water inlet port. The flow detection device 720 may be a flow sensor, and the fluid level detection device 110 may be a fluid level sensor. Further, a ninth on-off valve 730 is further disposed on the water intake pipeline 700, and is located upstream of the fourth on-off valve 710.

[0029] Optionally, the gas intake system further includes a purging pipeline 920 and a drainage pipeline 800, a first end of the purging pipeline 920 is in on-off communication with the water inlet pipeline 700, a first end of the drainage pipeline 800 is in on-off communication with a drainage port of the water storage tank 100, a second end of the purging pipeline 920 is configured to be connected to a purge gas source, and a purge gas may be nitrogen. When the water storage tank 100 is cleaned, the drainage pipeline 800 and the purging pipeline 920 may be opened to drain the liquid water from the water storage tank 100, at this time, the purge gas is introduced into the purging pipeline 920

to balance a gas pressure in the water storage tank 100. In addition, the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400 may be purged by introducing the purge gas into the purging pipeline 920. Further, the purging pipeline 920 is provided with the eighth on-off valve 921 and a second one-way valve 922, and the drainage pipeline 800 is provided with the sixth on-off valve 810. A conduction direction of the second one-way valve 922 is a direction extending from a second end of the drainage pipeline 800 to the first end of the drainage pipeline 800.

[0030] Optionally, the first heating device 260 may be a conventional electric heater, but the conventional electric heater cannot heat the liquid water uniformly, that is, there may be a problem that part of the liquid water in the water storage tank 100 is heated while the remaining liquid water is not heated. Therefore, in an alternative embodiment, the first heating device 260 wraps around the water storage tank 100, so that the first heating device 260 can heat the liquid water uniformly. The gas intake system further includes a second heating device 210, which wraps around the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400, and a heating temperature of the second heating device 210 is greater than or equal to that of the first heating device 260. If the second heating device 210 is not provided, when the water vapor passes through the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400, the water vapor may liquefy due to lower temperatures of the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400, resulting in unstable flow of the water vapor entering the process chamber 500. In the embodiment of the present disclosure, the second heating device 210 is provided and has the heating temperature greater than or equal to that of the first heating device 260, so that the liquefaction of the water vapor can be avoided. In addition, the second heating device 210 may be divided into three heating sections, which respectively wrap around the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400 in a one-to-one correspondence manner, so as to realize independent control of a heating temperature of each heating section. Certainly, the second heating device 210 may be divided into two heating sections. Both the first heating device 260 and the second heating device 210 may adopt an electric heating method or a heat exchange method to heat the liquid water.

[0031] In an alternative embodiment, the gas intake system further includes a first temperature detection element, a second temperature detection element 230, a first

over-temperature switch 240, and a second over-temperature switch 250, the first temperature detection element and the first over-temperature switch 240 are both disposed at the water storage tank 100, and the second temperature detection element 230 and the second over-temperature switch 250 are both disposed at the gas storage tank 200. The first temperature detection element may be closely attached to an outer wall of the water storage tank 100 for detecting a temperature of the water storage tank 100, and the second temperature detection element 230 may be closely attached to an outer wall of the gas storage tank 200 for detecting a temperature of the gas storage tank 200. When the temperature of the water storage tank 100 is too high, the first over-temperature switch 240 may output an alarm signal and turn off the first heating device 260; and when the temperature of the gas storage tank 200 is too high, the second over-temperature switch 250 may output an alarm signal and turn off the second heating device 210, thereby preventing damage to the first heating device 260 and the second heating device 210 and reducing potential safety hazards.

[0032] Optionally, the gas storage tank 200 is provided with a pressure detection device 220 for detecting the pressure in the gas storage tank 200.

[0033] As shown in FIG. 6, an embodiment of the present disclosure further discloses a semiconductor process device, which includes a process chamber 500 and the gas intake system described in any of the above embodiments, and the gas intake system is in on-off communication with the process chamber 500, that is, the gas storage tank 200 may be in on-off communication with the process chamber 500 through the gas supply pipeline 400.

[0034] In an alternative embodiment, the semiconductor process device further includes a machine main body 930, a processing module 931, a communication module 932, an analog input module 933, a digital input module 934, a digital output module 935, and a temperature control module 936, the processing module 931 is electrically connected to the machine main body 930 through the communication module 932, and is respectively electrically connected to the analog input module 933, the digital input module 934, and the digital output module 935, and the temperature control module 936 is electrically connected to the first heating device 260. The digital input module 934 may be respectively electrically connected to the first over-temperature switch 240 and the second over-temperature switch 250, the temperature control module 936 may be respectively electrically connected to the first heating device 260 and the second heating

device 210, the digital output module 935 may be electrically connected to the first on-off valve 420, the fourth on-off valve 710, the fifth on-off valve 310, and the sixth on-off valve 810, the digital input module 934 may be respectively electrically connected to the flow detection device 720, the liquid level detection device 110, the pressure detection device 220, the first temperature detection element, and the second temperature detection element 230, and the flow rate control device 410 may be electrically connected to the communication module 932. Exemplarily, the processing module 931 may take a 16-bit MSP430F single chip microcomputer as a core, and is responsible for signal processing and logical operations, which include communicating with the machine main body 930 of the semiconductor process device through the communication module 932, receiving control information issued by the machine main body 930, and feeding back a system state to the machine main body 930, and the communication module 932 may support a plurality of communication protocols such as Ethernet, Devicenet, and RS485, so as to be connected to the machine main body 930 or other debugging computers. Meanwhile, the processing module 931 receives, through the analog input module 933, analog signals fed back by the liquid level detection device 110, the pressure detection device 220, the first temperature detection element, the second temperature detection element 230, and the flow detection device 720, and converts the analog signals into corresponding liquid levels, pressures, temperatures or flow, and the processing module 931 receives, through the digital input module 934, over-temperature signals from the first over-temperature switch 240 and the second over-temperature switch 250, and controls, through the digital output module 935, on or off of all the on-off valves such as the first on-off valve 420, the fourth on-off valve 710, the fifth on-off valve 310, and the sixth on-off valve 810. The machine main body 930 may be controlled manually or with an automatic process, so as to control on or off of the first on-off valve 420, the fourth on-off valve 710, the fifth on-off valve 310, and the sixth on-off valve 810, and coordinate the processing module 931 to realize water vapor intake control of the gas intake system. The temperature control module 936 may respectively control temperatures of the first heating device 260 and the second heating device 210. Further, the semiconductor process device further includes a power module 937 and a machine power box 938, and the machine power box 938 is respectively electrically connected to the power module 937 and the machine main body 930. The machine power box 938 may respectively supply power to the machine main body 930

and the power module 937, and the power module 937 may supply power to each module.

[0035] Optionally, the second on-off valve 430, the third on-off valve 610, the seventh on-off valve 911, the eighth on-off valve 921, and the ninth on-off valve 730 may be pneumatic valves, and the machine main body 930 are respectively electrically connected to the above pneumatic valves. The first on-off valve 420, the fourth on-off valve 710, the fifth on-off valve 310, and the sixth on-off valve 810 may be solenoid valves. Further, the semiconductor process device further includes a solenoid valve set 940, the second on-off valve 430, the third on-off valve 610, the seventh on-off valve 911, the eighth on-off valve 921, and the ninth on-off valve 730 are respectively electrically connected to the solenoid valve set 940, and the machine main body 930 may control actions of the solenoid valve set 940, so as to control on and off of the second on-off valve 430, the third on-off valve 610, the seventh on-off valve 911, the eighth on-off valve 921, and the ninth on-off valve 730.

[0036] As shown in FIG. 3 to FIG. 5, an embodiment of the present disclosure further discloses a gas intake method, which is applied to the gas intake system described in any of the above embodiments and includes the following steps S100 to S500.

[0037] At S100, liquid water is introduced into the water storage tank 100 until a water storage amount in the water storage tank 100 reaches a preset water storage amount.

[0038] The liquid water may be introduced into the water storage tank 100 through the water inlet port, and the preset water storage amount may be determined according to different process requirements, and is between an overflow water storage amount and a replenishment water storage amount.

[0039] At S200, the liquid water is heated to a preset temperature, the water vapor conveying pipeline 300 is controlled to be in an on state, and the water inlet port is controlled to be in an off state.

[0040] The preset temperature is a temperature at which the liquid water can generate water vapor meeting process requirements, and may be determined according to different process requirements, for example, the preset temperature may range from 85°C to 95°C.

Optionally, the preset temperature does not exceed 95°C. When the temperature of the liquid water exceeds 95°C, a liquid level in the water storage tank 100 may fluctuate, with the result that a liquid level detected by the liquid level detection device 110 is not accurate. The fifth on-off valve 310 is opened and the fourth on-off valve 710 is closed,

so that the water vapor conveying pipeline 300 may be in the on state, and the water inlet port may be in the off state, at this time, the water inlet port of the water storage tank 100 stops the introduction of the liquid water, and water vapor in the water storage tank 100 is introduced into the gas storage tank 200 through the water vapor conveying pipeline 300.

[0041] At S300, when a pressure in the gas storage tank 200 reaches a preset pressure, the gas supply pipeline 400 is controlled to be in an on state, and the water vapor conveying pipeline 300 is controlled to be in an off state.

[0042] The preset pressure is lower than a gas pressure in the water storage tank 100 and higher than a replenishment pressure, the replenishment pressure is higher than a start pressure of the flow control device 410, and the start pressure of the flow control device 410 is higher than an operating pressure of the process chamber 500, which may be determined according to different process requirements. The first on-off valve 420, the flow control device 410, and the second on-off valve 430 are opened, and the fifth on-off valve 310 is closed, so that the gas supply pipeline 400 may be controlled to be in an on state, and the water vapor conveying pipeline 300 may be controlled to be in an off state, at this time, the introduction of the water vapor into the gas storage tank 200 through the water vapor conveying pipeline 300 is stopped, and the water vapor in the gas storage tank 200 is introduced into the process chamber 500 through the gas supply pipeline 400.

[0043] At S400, when the water storage amount in the water storage tank 100 is less than the replenishment water storage amount, the water vapor conveying pipeline 300 is controlled to be in an off state, and the water inlet port is controlled to be in an on state.

[0044] The replenishment water storage amount may be determined according to different process requirements.

[0045] At S500, when the pressure in the gas storage tank 200 is lower than the replenishment pressure, the water inlet port is controlled to be in an off state, and the water vapor conveying pipeline 300 is controlled to be in an on state.

[0046] The replenishment pressure may be determined according to different process requirements.

[0047] It should be noted that it can be known from a relationship between a temperature and a saturated water vapor pressure, the ideal gas equation $pV = nRT$ (where p denotes a gas pressure, V denotes a gas volume, n denotes amount of gaseous substance, T denotes a system temperature, and R denotes a proportionality coefficient), and a

relationship between gas mass and amount of substance $m = M \times n$ (m denotes gas mass, M denotes molar mass, and n denotes amount of gaseous substance) that the water vapor gradually enters the process chamber 500 from the gas storage tank 200 during the process, and a volume of the water vapor which enters the process chamber 500 from the gas storage tank 200 may be obtained by a calculation according to flow set by the flow control device 410 and time. The process time (recorded as t_1) during which the water vapor in the gas storage tank 200 can support water vapor flow required by the process is calculated by the above formulas, and meanwhile, replenishment and heating time (recorded as t_2) of the water storage tank 100 may be calculated according to water intake flow, latent heat of vaporization of the liquid water, and heating power of the first heating device 260, and it may be obtained that $t_1 > t_2$, that is, the sum of the replenishment time for the liquid water in the water storage tank 100 to rise from the replenishment water storage amount to the preset water storage amount and heating evaporation time is less than the time for the process chamber 500 to consume the water vapor, so that the embodiment of the present disclosure is achievable.

[0048] In the embodiment of the present disclosure, both the water inlet port and the water vapor conveying pipeline 300 may be in an off state during a process. In a case where one of the water inlet port and the water vapor conveying pipeline 300 is in an on state, the other is in an off state; that is, the water inlet port and the water vapor conveying pipeline 300 cannot be opened at the same time, that is: when the water storage amount in the water storage tank 100 is less than the replenishment water storage amount, the water vapor conveying pipeline 300 is controlled to be in the off state, and the water inlet port is opened; and when the pressure in the gas storage tank 200 is lower than the replenishment pressure, the water inlet port is closed, and the water vapor conveying pipeline 300 is opened. If the water storage tank 100 and the gas storage tank 200 are opened at the same time, the liquid water at room temperature may reduce a temperature of the water storage tank 100 when entering the water storage tank 100 in a process of replenishing the water storage tank 100 with the liquid water, such that condensation of part of the water vapor in the water storage tank 100 is caused, and a concentration of the water vapor is reduced, which may result in unstable flow of the water vapor in the water storage tank 100 when entering the gas storage tank 200, and further cause unstable flow of the water vapor in the gas storage tank 200 when entering the chamber 500. According to the embodiment of the present disclosure, the water inlet

port and the water vapor conveying pipeline 300 are not opened at the same time, so that the water vapor with the unstable flow generated while replenishing the water storage tank 100 with the liquid water can be prevented from entering the gas storage tank 200, thereby preventing the water vapor with the unstable flow from entering the process chamber 500.

[0049] In an alternative embodiment, the gas intake system includes the suction pipeline 600, and step S100 may include the following steps S110 to S130.

[0050] At S110, the water inlet port and the water vapor conveying pipeline 300 are controlled to be in an on state, and the suction pipeline 600 is controlled to be communicated with the gas supply pipeline 400, that is, the suction pipeline 600 is communicated with a pipe section of the gas supply pipeline 400 which is upstream of the second on-off valve 430, and a gas in the water storage tank 100 is sucked through the suction pipeline 600, so as to allow the liquid water to be introduced into the water storage tank 100.

[0051] Here, the fourth on-off valve 710, the fifth on-off valve 310, the first on-off valve 420, the flow control device 410, and the third on-off valve 610 may be opened, so as to suck the gas in the water storage tank 100, thereby avoiding the problem that the water storage amount in the water storage tank 100 cannot meet a requirement for a long time in the process of introducing the liquid water into the water storage tank 100 because the liquid water cannot be introduced into the water storage tank 100 after the water storage amount in the water storage tank 100 reaches a certain amount due to an increase in the pressure in the water storage tank 100 caused by the introduction of the liquid water into the water storage tank 100.

[0052] At S120, the water storage amount in the water storage tank 100 is detected.

[0053] The water storage amount in the water storage tank 100 may be acquired only by the flow detection device 720 or only by the liquid level detection device 110, and may be also acquired by both the flow detection device 720 and the liquid level detection device 110, so as to improve detection precision of the water storage amount.

[0054] At S130, when the water storage amount reaches the preset water storage amount, the water inlet port and the water vapor conveying pipeline 300 are controlled to be in an off state, at this time, the fourth on-off valve 710 and the fifth on-off valve 310 may be closed. It should be noted that if a gas tank initialization step described below does not need to be performed after step S130, the gas supply pipeline 400 and the suction

pipeline 600 need to be in an off state; and if the gas tank initialization step needs to be performed after step S130, the suction pipeline 600 may be continued to be communicated with the gas supply pipeline 400.

[0055] In an alternative embodiment, step S200 further includes the gas tank initialization step before controlling the water vapor conveying pipeline 300 to be in the on state; and it should be noted that the gas tank initialization step may be performed before the water vapor conveying pipeline 300 is controlled to be in the on state or before the liquid water is heated to the preset temperature.

[0056] The gas tank initialization step includes:

S201, controlling the suction pipeline 600 to be communicated with the gas supply pipeline 400, and controlling the water vapor conveying pipeline 300 to be in an off state, at this time, opening the flow control device 410, the first on-off valve 420, and the third on-off valve 610, and closing the fifth on-off valve 310;

S202, sucking the gas from the gas storage tank 200 through the suction pipeline 600; and in this way, not only can the pressure in the gas storage tank 200 be reduced to allow the water vapor generated in the water storage tank 100 to enter the gas storage tank 200, but also the air can be sucked from the gas storage tank 200, and purity of the water vapor can be ensured; and

S203, when the pressure in the gas storage tank 200 reaches a first preset threshold, controlling both the suction pipeline 600 and the gas supply pipeline 400 to be in an off state. The first preset threshold may be selected according to actual situations. Optionally, the first preset threshold is a background pressure, that is, when the pressure in the gas storage tank 200 does not change any more during the suction on the gas storage tank 200, such pressure is the background pressure. In this way, more air can be sucked from the gas storage tank 200, which further ensures the purity of the water vapor.

[0057] In an alternative embodiment, the water storage tank 100 is further provided with an overflow port, and the gas intake method further includes:

S600, when the water storage amount in the water storage tank 100 is larger than the overflow water storage amount, controlling the overflow port to be in an on state. When the water storage amount in the water storage tank 100 is too large, the liquid water may occupy the space of the water vapor, which reduces a storage amount of the water vapor. Part of the water in the water storage tank 100 can be discharged through the overflow

port to allow the water storage amount to reach the preset water storage amount, thereby avoiding the problem that the liquid water occupies the space of the water vapor.

[0058] Before the water storage tank 100 is replenished with the liquid water and heated for the first time or when airtightness of the gas intake system needs to be detected, leakage rate detection may be performed on the gas intake system. In an alternative embodiment, step S100 further includes a leakage rate detection step before introducing the liquid water into the water storage tank 100, and the leakage rate detection step includes:

S101, controlling the water inlet port to be in an off state, controlling the water vapor conveying pipeline 300 to be in an on state, controlling the suction pipeline 600 to be communicated with the gas supply pipeline 400, at this time, closing the fourth on-off valve 710, and opening the fifth on-off valve 310, the first on-off valve 420, the flow control device 410, and the third on-off valve 610;

S102, sucking the gas from the water storage tank 100, the water vapor conveying pipeline 300, the gas storage tank 200, and the gas supply pipeline 400 (specifically, a pipe section upstream of the third on-off valve 610) through the suction pipeline 600;

S103, when the pressure of the gas storage tank 200 reaches a second preset threshold, controlling the suction pipeline 600 to be in an off state;

S104, measuring a first pressure in the gas storage tank 200, with the first pressure recorded as P11; and the first pressure may be equal to the second preset threshold or not;

S105, measuring a second pressure in the water storage tank 100 after a preset period of time passes, with the preset period of time recorded as t, and the second pressure recorded as P12; and

S106, obtaining a leakage rate of the gas intake system according to the first pressure, the second pressure, and the preset period of time. The leakage rate of the gas intake system is $LR = (P12 - P11) / t$. In the embodiment of the present disclosure, the leakage rate of the gas intake system may be determined in advance, and the step of introducing the liquid water into the water storage tank 100 may be performed when the leakage rate meets a requirement.

[0059] In an alternative embodiment, the gas intake method further includes a temperature detection step, which includes:

S710, detecting a temperature of the water storage tank 100;

S720, in a case where the temperature is lower than a first preset temperature, closing the water vapor conveying pipeline 300, and increasing power of the first heating device 260; and

S730, in a case where the temperature is higher than a second preset temperature, reducing the power of the first heating device 260 or turning off the first heating device 260. In the embodiment of the present disclosure, the temperature of the liquid water in the water storage tank 100 can be controlled to be kept between the first preset temperature and the second preset temperature, so that the water vapor meeting process requirements can be generated.

[0060] The above embodiments of the present disclosure focus on the differences between the embodiments, and different optimization features of the embodiments can be combined to form better embodiments as long as the different optimization features are not contradictory, which will not be described in detail here for conciseness of the description.

[0061] The description above is only of the embodiments of the present disclosure, but is not intended to limit the present disclosure. Various modifications and changes may be made to the present disclosure by those of ordinary skill in the art. Any modification, equivalent replacement and improvement made within the spirit and the principle of the present disclosure should be included in the scope of the present disclosure.

What is claimed is:

1. A gas intake system for a semiconductor process device, comprising a water storage tank, a gas storage tank, a water vapor conveying pipeline, and a gas supply pipeline, wherein the water storage tank is provided with a water inlet port capable of being opened and closed, and a first heating device is disposed on the water storage tank,

two ends of the water vapor conveying pipeline are respectively in on-off communication with a gas outlet of the water storage tank and a gas inlet of the gas storage tank, and a gas outlet of the gas storage tank is in on-off communication with a process chamber of the semiconductor process device through the gas supply pipeline, and

in a case where one of the water inlet port and the water vapor conveying pipeline is in an on state, the other is in an off state.

2. The gas intake system of claim 1, wherein the gas supply pipeline is provided with a flow control device, a first on-off valve, and a second on-off valve, the flow control device is located downstream of the first on-off valve, and the second on-off valve is located downstream of the flow control device.

3. The gas intake system of claim 2, further comprising a suction pipeline, wherein a first end of the suction pipeline is in on-off communication with the gas supply pipeline, and is located between the flow control device and the second on-off valve.

4. The gas intake system of claim 2, further comprising a gas mixing pipeline, wherein a first end of the gas mixing pipeline is in on-off communication with the gas supply pipeline, and is located downstream of the second on-off valve.

5. The gas intake system of claim 1, further comprising a water inlet pipeline, which is in on-off communication with the water inlet port, wherein the water inlet pipeline is provided with a flow detection device, the water storage tank is provided with a liquid level detection device, and the flow detection device and the liquid level

detection device are both configured to acquire a water storage amount in the water storage tank.

6. The gas intake system of claim 1, wherein the first heating device wraps around the water storage tank, and the gas intake system further comprises a second heating device, which wraps around the water vapor conveying pipeline, the gas storage tank, and the gas supply pipeline, and

a heating temperature of the second heating device is greater than or equal to a heating temperature of the first heating device.

7. The gas intake system of claim 6, further comprising a first temperature detection element, a second temperature detection element, a first over-temperature switch, and a second over-temperature switch, the first temperature detection element and the first over-temperature switch are both disposed at the water storage tank, and the second temperature detection element and the second over-temperature switch are both disposed at the gas storage tank.

8. A semiconductor process device, comprising a process chamber and the gas intake system of any one of claims 1 to 7, wherein the gas intake system is in on-off communication with the process chamber.

9. The semiconductor process device of claim 8, further comprising a machine main body, a processing module, a communication module, an analog input module, a digital input module, a digital output module, and a temperature control module, and the processing module is electrically connected to the machine main body through the communication module, and is respectively electrically connected to the analog input module, the digital input module, and the digital output module, and the temperature control module is electrically connected to the first heating device.

10. A gas intake method applied to the gas intake system of any one of claims 1 to 7, comprising:

introducing liquid water into the water storage tank until a water storage amount in the water storage tank reaches a preset water storage amount;

heating the liquid water to a preset temperature, controlling the water vapor conveying pipeline to be in an on state, and controlling the water inlet port to be in an off state;

5 when a pressure in the gas storage tank reaches a preset pressure, controlling the gas supply pipeline to be in an on state, and controlling the water vapor conveying pipeline to be in an off state;

when the water storage amount in the water storage tank is less than a replenishment water storage amount, controlling the water vapor conveying pipeline to be in an off state, and controlling the water inlet port to be in an on state; and

10 when the pressure in the gas storage tank is lower than a replenishment pressure, controlling the water inlet port to be in an off state, and controlling the water vapor conveying pipeline to be in an on state.

11. The gas intake method of claim 10, wherein the gas intake system
15 comprises a suction pipeline, and

introducing the liquid water into the water storage tank until the water storage amount in the water storage tank reaches the preset water storage amount comprises:

controlling the water inlet port and the water vapor conveying pipeline to be in an on state, and controlling the suction pipeline to be communicated with the gas
20 supply pipeline to suck a gas from the water storage tank through the suction pipeline, so as to allow the liquid water to be introduced into the water storage tank;

detecting the water storage amount in the water storage tank; and

when the water storage amount reaches the preset water storage amount, controlling the water inlet port and the water vapor conveying pipeline to be in an off
25 state.

12. The gas intake method of claim 10, wherein the gas intake system comprises a suction pipeline, and

before controlling the water vapor conveying pipeline to be in the on state, the
30 gas intake method further comprises a gas tank initialization step; and

the gas storage tank initialization step comprises:

controlling the suction pipeline to be communicated with the gas supply pipeline, and controlling the water vapor conveying pipeline to be in an off state;

sucking a gas from the gas storage tank through the suction pipeline; and
when the pressure in the gas storage tank reaches a first preset threshold,
controlling both the suction pipeline and the gas supply pipeline to be in an off state.

5 13. The gas intake method of claim 10, wherein the water storage tank is
further provided with an overflow port, and the gas intake method further comprises:
when the water storage amount in the water storage tank is larger than an
overflow water storage amount, controlling the overflow port to be in an on state.

10 14. The gas intake method of claim 10, wherein the gas intake system
comprises a suction pipeline,
before introducing the liquid water into the water storage tank, the gas intake
method further comprises a leakage rate detection step, which comprises:
controlling the water inlet port to be in an off state, controlling the water vapor
15 conveying pipeline to be in an on state, and controlling the suction pipeline to be
communicated with the gas supply pipeline;
sucking a gas from the water storage tank, the water vapor conveying pipeline,
the gas storage tank, and the gas supply pipeline through the suction pipeline;
when the pressure of the gas storage tank reaches a second preset threshold,
20 controlling the suction pipeline to be in an off state;
measuring a first pressure in the gas storage tank;
measuring a second pressure in the water storage tank after a preset period of
time passes; and
obtaining a leakage rate of the gas intake system according to the first pressure,
25 the second pressure, and the preset period of time.

15. The gas intake method of claim 10, further comprising a temperature
detection step, which comprises:
detecting a temperature of the water storage tank;
30 in a case where the temperature is lower than a first preset temperature, closing
the water vapor conveying pipeline, and increasing power of the first heating device;
and
in a case where the temperature is higher than a second preset temperature,

reducing the power of the first heating device or turning off the first heating device.