CLEANING METHOD AND CLEANING SYSTEM FOR SEMICONDUCTOR STORAGE CONTAINER

CROSS-REFERENCE TO THE RELATED APPLICATIONS

[0001] The present disclosure claims priority to Chinese Patent Application No. 202410167763.9, filed on February 6, 2024, and entitled "CLEANING METHOD AND CLEANING SYSTEM FOR SEMICONDUCTOR STORAGE CONTAINER", the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of semiconductor wafer manufacturing, and in particular, to a cleaning method and a cleaning system for a semiconductor storage container.

BACKGROUND

[0003] In the process of semiconductor wafer manufacturing, wafers are stored in FOUPs (Front Opening Unified Pods) for transfer between different process equipment. Since wafers produce AMC (airborne molecular contaminants) on wafer surfaces after undergoing different processes, contaminated wafers entering and exiting FOUPs can cause cross-contamination, that is, AMC exhausted from contaminated wafers remains in the FOUPs, thereby contaminating the next batch of wafers stored in the same FOUP.

[0004] Therefore, FOUPs are periodically sent to dedicated cleaning systems for cleaning to ensure the cleanliness of the FOUPs. Existing FOUP cleaning systems mainly remove particles, metals, humidity, AMC and other contaminants inside the FOUPs through liquid rinsing, drying, vacuum treatment and other means.

[0005] However, the above cleaning processes have limited cleaning capability for AMC contaminants, resulting in an inability to meet increasingly higher process requirements.

SUMMARY

[0006] In view of the foregoing, embodiments of the present disclosure provide a cleaning method for a semiconductor storage container to solve at least one of the problems existing in the background art.

[0007] The present disclosure provides a cleaning method for a semiconductor storage container, comprising the following steps: step one, placing the semiconductor storage container

at a loading unit; step two, transferring the container to a first processing unit, and performing cleaning and drying on the container in the first processing unit; step three, transferring the container to a second processing unit, and utilizing a vacuum environment in the second processing unit to remove residual AMC contaminants inside the container and further dry the container; and step four, transferring the container to an unloading unit, and detecting the container in the unloading unit, and determining a subsequent processing mode according to detection results.

[0008] Optionally, the cleaning method further comprises transferring the semiconductor storage container to a detection unit to detect a contaminant residual level inside the semiconductor storage container.

[0009] Optionally, the cleaning method further comprises detecting the semiconductor storage container in the loading unit and/or the unloading unit.

[0010] Optionally, the cleaning method further comprises detecting the first processing unit and/or the second processing unit, and determining an internal contaminant level through detection results.

[0011] The present disclosure further provides a semiconductor storage container cleaning system, comprising a loading unit, a first processing unit, a second processing unit, an unloading unit and a manipulator, wherein the loading unit is configured to load the semiconductor storage container; the first processing unit is configured to clean and purge the semiconductor storage container; the second processing unit is configured to dry the semiconductor storage container; the detection unit is configured to detect a residual value of contaminants of the cleaned semiconductor storage container; and the unloading unit is configured to unload the semiconductor storage container.

[0012] In a first aspect, the present disclosure provides a cleaning method for a semiconductor storage container, wherein the cleaning method is configured to remove residual AMC contaminants inside the semiconductor storage container, and in the above step two, the cleaning method further comprises the following steps: S12, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber; S13, blowing clean dry compressed gas onto a surface of the semiconductor storage container at a fifth average volumetric flow rate for a duration T_{S13}; S14, spraying cleaning liquid onto the surface of the semiconductor storage container to clean the surface of the semiconductor storage container; and S15, blowing clean dry compressed gas onto the surface of the semiconductor storage container.

[0013] The present disclosure utilizes clean dry compressed gas to blow the surface of the semiconductor storage container before spray cleaning, thereby better removing AMC contaminants attached to the surface of the semiconductor storage container.

[0014] Optionally, the duration T_{S13} in step S13 is 10-80 s, and the fifth average volumetric flow rate is 1000-3000 LPM.

[0015] Optionally, the temperature of the clean dry compressed gas in step S13 and/or step S15 is greater than or equal to 40 °C, and less than or equal to 80 °C.

[0016] Optionally, in step S13, step S14 and step S15, a heating component is utilized to heat the first processing unit, so that an ambient temperature in a first cleaning chamber in the first processing unit is greater than or equal to 40 °C, and less than or equal to 80 °C.

[0017] Optionally, the clean dry compressed gas and the cleaning liquid share the same supply system.

[0018] Optionally, step S15 further comprises the steps of:

[0019] S151, blowing clean dry compressed gas onto the surface of the semiconductor storage container for a duration T_{S151} to remove residual cleaning liquid in a pipeline; and

[0020] S152, blowing clean dry compressed gas onto the surface of the semiconductor storage container for a duration T_{S152} to remove moisture on the surface of the semiconductor storage container and dry the semiconductor storage container.

[0021] A flow rate of the clean dry compressed gas blown onto the surface of the semiconductor storage container in step S151 is greater than a flow rate of the clean dry compressed gas blown onto the surface of the semiconductor storage container in step S152; and the duration T_{S151} is less than the duration T_{S152}.

[0022] Optionally, during the process of cleaning the semiconductor storage container in the first cleaning chamber, a contaminant residual level of gas discharged from the first cleaning chamber is detected, thereby determining whether to stop cleaning.

[0023] Optionally, after step S15, the cleaning method further comprises the step of:

[0024] S16, after the semiconductor storage container is removed from the first cleaning chamber, cleaning the first cleaning chamber to reduce an internal contaminant residual level thereof.

[0025] The present disclosure further discloses a cleaning unit adopting the above cleaning method.

[0026] The present disclosure further discloses a cleaning system, comprising the above cleaning unit.

[0027] In a second aspect, the present disclosure further provides a cleaning method of the semiconductor storage container based on detection results, and in the above step two, the cleaning method further comprises the following steps: S31, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber; S32, cleaning the semiconductor storage container in the first cleaning chamber using cleaning liquid; S33, detecting contaminants in the first cleaning chamber to obtain detection results, wherein the types of detected contaminants include particles and/or AMC; and S34, performing subsequent processing according to the detection results. By detecting the contaminant level in the first cleaning chamber, a contaminant residual level inside the semiconductor storage container can be indirectly determined, providing data support for subsequent cleaning, thereby better cleaning the semiconductor storage container.

[0028] Optionally, in the above step S33, the AMC includes one or more of SO_2, inorganic ammonia, VOC, organic amines, and acids.

[0029] Optionally, step S34 comprises: setting a first preset threshold according to process parameters, wherein the first preset threshold is set comprehensively according to a cleaning processing capability of the first cleaning chamber, a container type, and process-required container index conditions; and determining whether the detection results are below the first preset threshold, wherein if the detection results are below the first preset threshold, the semiconductor storage container completes the cleaning process in the present cleaning chamber; otherwise, repeating steps S32 and S33.

[0030] By comparing the detection results with the first preset threshold, it can be ensured that the semiconductor storage container is transferred to a next cleaning procedure only after reaching a preset cleanliness level, thereby effectively improving a qualification rate of cleaning semiconductor storage containers.

[0031] Optionally, in step S33, the cleaning method further comprises setting a second preset threshold according to process parameters, wherein the second preset threshold is greater than the first preset threshold, and the second preset threshold is set comprehensively according to the cleaning processing capability of the first cleaning chamber, the container type, and the process-required container index conditions. If the detection results are higher than the second preset threshold, a control unit connected to a detection device issues a warning signal.

[0032] Optionally, in step S34, the cleaning method further comprises determining process parameters of a cleaning system in subsequent processing according to the detection results.

[0033] Optionally, after step S34, the cleaning method further comprises step S35: after the first cleaning chamber completes cleaning of the semiconductor storage container and the

semiconductor storage container is removed from the first cleaning chamber, cleaning the first cleaning chamber.

[0034] Optionally, after step S34, the cleaning method further comprises step S36: after the semiconductor storage container is removed from the first cleaning chamber, detecting a contaminant level in the first cleaning chamber, and determining whether an environment of the first cleaning chamber meets a requirement for cleaning the semiconductor storage container.

[0035] Optionally, step S36 specifically comprises: setting a preset value of the contaminant level according to process parameters of the first processing unit, wherein if a detected value of the contaminant level exceeds the preset value, the equipment issues a warning signal to indicate that equipment maintenance is required. Otherwise, the first cleaning chamber cleans a next semiconductor storage container.

[0036] The embodiments of the present disclosure further disclose a cleaning unit adopting the above cleaning method.

[0037] The embodiments of the present disclosure further disclose a cleaning system, comprising the above cleaning unit.

[0038] In a third aspect, step three of the present disclosure provides another cleaning method for a semiconductor storage container, wherein the cleaning method is configured to remove residual AMC contaminants inside the semiconductor storage container, and the above step three further comprises the following steps:

[0039] S21, placing a cleaned semiconductor storage container in a second cleaning chamber;

[0040] S22, vacuumizing the second cleaning chamber for a duration T_{S22}, so that a pressure in the second cleaning chamber is less than or equal to a first preset pressure value, and maintaining a temperature in the second cleaning chamber between 40-80 °C;

[0041] S23, filling the second cleaning chamber with gas at a first average volumetric flow rate for a duration T_{S23}, and maintaining a maximum pressure value in the second cleaning chamber during step S23 to be less than or equal to a second preset pressure value, wherein the gas is clean dry compressed gas; and

[0042] S24, filling the second cleaning chamber with gas at a second average volumetric flow rate for a duration T_{S24}, and maintaining a maximum pressure value in the second cleaning chamber during step S24 to be less than or equal to a third preset pressure value, wherein the gas is clean dry compressed gas,

[0043] wherein the first average volumetric flow rate is less than the second average volumetric flow rate, and the maximum pressure value in the second cleaning chamber during

step S23 is less than the maximum pressure value in the second cleaning chamber during step S24.

[0044] Optionally, in the above step S23 and step S24, the gas is nitrogen gas and/or inert gas.

[0045] Optionally, after step S24, the cleaning method further comprises S25: cycling step S22, step S23 and step S24 for several times, wherein in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than or equal to a minimum pressure value in the second cleaning chamber in the previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than or equal to a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

[0046] Optionally, after step S24, the cleaning method further comprises: S25: cycling step S22, step S23 and step S24 for several times, wherein in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than a minimum pressure value in the second cleaning chamber in the previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

[0047] Optionally, in step S22, the cleaning method comprises: maintaining a pressure value of the second cleaning chamber to be less than or equal to the first preset pressure value for a duration T_{S222}.

[0048] Optionally, the duration T_{S26} is less than the duration T_{S22}.

[0049] Optionally, in step S23, vacuumizing the second cleaning chamber is maintained.

[0050] Optionally, the first preset pressure value is less than or equal to 100 Pa.

[0051] Optionally, the duration T_{S22} is 10-300 s.

[0052] Optionally, the first volumetric flow rate is 5-100 LPM.

[0053] Optionally, the duration T_{S23} is 1-100s.

[0054] The present disclosure further includes a cleaning system adopting the above cleaning method for a semiconductor storage container, wherein the cleaning system comprises:

[0055] a second cleaning chamber configured to accommodate the semiconductor storage container;

[0056] a vacuum pump, wherein the vacuum pump is connected to the second cleaning chamber and configured to vacuumize the second cleaning chamber;

[0057] a pressure detection member, wherein the pressure detection member is connected to the second cleaning chamber and configured to detect a pressure in the second cleaning chamber;

[0058] a heating component, wherein the heating component is connected to the second cleaning chamber and configured to heat gas in the second cleaning chamber; and

[0059] a vacuum breaking component, wherein the vacuum breaking component is connected to the second cleaning chamber and configured to fill gas into the second cleaning chamber, wherein the gas comprises nitrogen gas and/or inert gas.

[0060] In a fourth aspect, the present disclosure provides another cleaning method of the semiconductor storage container based on detection results, and the above step three further comprises the following steps: S41, placing a cleaned semiconductor storage container in a second cleaning chamber; S42, vacuumizing the second cleaning chamber for a duration T_{S42}; S43, filling the second cleaning chamber with gas to restore atmospheric pressure in the second cleaning chamber, wherein the gas comprises nitrogen gas and/or inert gas; S44, detecting a contaminant level in the second cleaning chamber to obtain detection results, wherein the detection results include AMC; and S45, performing subsequent processing according to the detection results.

[0061] Optionally, in the above step S44, the AMC includes one or more of SO_2, inorganic ammonia, VOC, organic ammonia, and acids.

[0062] Optionally, step S44 comprises detecting gas discharged from the second cleaning chamber in step S42 through a detection device to obtain the detection results.

[0063] Optionally, step S44 comprises detecting gas discharged from the second cleaning chamber in step S43 through a detection device to obtain the detection results.

[0064] Optionally, step S45 further comprises: setting a third preset threshold according to process parameters, wherein the third preset threshold is set comprehensively according to a cleaning processing capability of the second cleaning chamber, a container type, and process-required container index conditions; and determining whether the detection results are below the third preset threshold, and if the detection results are below the third preset threshold, transferring the semiconductor storage container to an unloading unit; otherwise, cycling steps S42 to S45.

[0065] Optionally, step S45 further comprises: setting a fourth preset threshold according to process parameters, wherein the fourth preset threshold is greater than the third preset threshold, and the fourth preset threshold is set comprehensively according to the cleaning processing capability of the second cleaning chamber, the container type, and the process-required container index conditions. If the detection results are higher than the fourth preset threshold, a control unit connected to a detection device issues a warning signal.

[0066] Optionally, step S45 further comprises: adjusting process parameters in S42 and/or S43 according to the detection results.

[0067] Optionally, the cleaning method further comprises: before the second cleaning chamber cleans the container, detecting a contaminant residual level in the second cleaning chamber, and determining whether a contaminant level in an environment of the second cleaning chamber meets a requirement for cleaning the semiconductor storage container. If the requirement is not met, a control unit connected to a detection device issues a warning signal.

[0068] Optionally, step S43 comprises step S431 of filling the second cleaning chamber with gas at a first average volumetric flow rate for a duration T_{S431}, and maintaining a maximum pressure value in the second cleaning chamber to be less than or equal to a third preset pressure value, wherein the gas is clean dry compressed gas; and S432, filling the second cleaning chamber with gas at a second volumetric flow rate for a duration T_{S432}, wherein the gas is clean dry compressed gas;

[0069] Optionally, in the above step S431 and step S432, the gas is nitrogen gas and/or inert gas.

[0070] Optionally, in step S431, the vacuum pump is in a working state, and vacuumizing the second cleaning chamber is maintained.

[0071] Optionally, step S41 further comprises detecting a contaminant residual level inside an uncleaned container, and determining whether to clean the semiconductor storage container in the second cleaning chamber.

[0072] The present disclosure further discloses a cleaning unit adopting the above cleaning method.

[0073] The present disclosure further discloses a cleaning system, comprising the above cleaning unit.

[0074] In the first aspect, compared with existing cleaning methods, the cleaning method of the present disclosure first proposes adding a gas blowing step before cleaning liquid spray cleaning, and by blowing clean dry compressed gas onto a container surface, AMC contaminants and particulate matter attached to the container surface can be effectively removed. Compared with blowing gas after cleaning liquid spray in existing methods, before cleaning liquid spray, the container surface is in a dry state, and at this time, the exterior of AMC contaminants and particulate matter is not covered by a liquid film, so they are more easily removed by gas blowing, thereby greatly improving the cleaning and removal effect of AMC contaminants.

[0075] Furthermore, the gas blowing process is one of the commonly used processes after cleaning liquid spray cleaning, and adding a gas blowing process before cleaning liquid spray cleaning does not cause significant changes to equipment structure, and adding this gas blowing

process before cleaning liquid spray cleaning does not additionally increase equipment manufacturing costs.

[0076] In the second aspect, based on different container types, different contaminant levels inside container cleaning chambers, and different process requirements for contaminant residual levels after container cleaning, the contaminant residual levels inside containers are also different after undergoing fixed process flows. The method of the present disclosure detects the contaminant level in an environment of the first cleaning chamber during the container cleaning process, thereby achieving a judgment of the contaminant residual level inside the container. On one hand, this ensures a pass rate of container cleaning, and on the other hand, the cleaning process can be adjusted according to the contaminant level of the container, avoiding over-cleaning while ensuring cleaning effectiveness.

[0077] In the third aspect, when cleaning in the second cleaning chamber, by first filling a small flow rate of gas into the second cleaning chamber in a negative pressure state, the filled gas is utilized to replace AMC in surface pores of the container, further reducing an AMC residual level in the semiconductor storage container. As the AMC residual level on the container surface decreases, the amount of AMC replaced by gas and the amount of AMC re-attached in the pores tend to be equal, and the AMC residual amount on the container surface tends to stabilize. At this time, by rapidly filling a larger volumetric flow rate of gas into the second cleaning chamber, a larger pressure gradient and concentration gradient can be formed near the surface pores of the container, which is conducive to diffusion of AMC molecules. Meanwhile, gas molecules enter the pores at a higher speed, flushing out AMC originally located in the pores.

[0078] Furthermore, when rapidly filling a larger volumetric flow rate of gas, the pressure in the second cleaning chamber increases, and the temperature in the second cleaning chamber also further increases. The temperature increase can further promote outward diffusion of AMC molecules in the surface pores of the container, thereby improving the AMC removal effect.

[0079] In the fourth aspect, based on different container types, different contaminant levels inside container cleaning chambers, and different process requirements for contaminant residual levels after container cleaning, the contaminant residual levels inside containers are also different after undergoing fixed process flows. The cleaning method provided by the present disclosure achieves a judgment of the contaminant residual level inside the container by detecting the contaminant level in an environment of the second cleaning chamber during the container cleaning process, thereby adjusting the cleaning process, and avoiding over-cleaning while ensuring cleaning effectiveness.

[0080] Additional aspects and advantages of the present disclosure will be set forth in part in the description which follows, and in part will be apparent from the description, or can be learned by practice of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0081] The drawings described herein are provided to provide a further understanding of the present disclosure and constitute a part of the present disclosure. The exemplary embodiments of the present disclosure and descriptions thereof are provided to explain the present disclosure and do not constitute an undue limitation on the present disclosure. In the drawings:

[0082] FIG. 1 is a schematic structural diagram of a container involved in an embodiment of the present disclosure;

[0083] FIG. 2 is an overall schematic structural diagram of a cleaning system for a semiconductor storage container provided by an embodiment of the present disclosure;

[0084] FIG. 3 is a schematic structural diagram of a cleaning system for a semiconductor storage container provided by an embodiment of the present disclosure;

[0085] FIG. 4 is a schematic structural diagram of a second cover body, a first positioning component and a knob assembly in the cleaning system for a semiconductor storage container provided by an embodiment of the present disclosure;

[0086] FIG. 5 is a top view of a barrel body in a cleaning device for a semiconductor storage container provided by an embodiment of the present disclosure;

[0087] FIG. 6 is a schematic diagram of surface pores and AMC contaminants on a container surface in a cleaning method for a semiconductor storage container provided by an embodiment of the present disclosure;

[0088] FIG. 7 is a schematic diagram of a liquid film formed on a container surface in a cleaning method for a semiconductor storage container provided by an embodiment of the present disclosure;

[0089] FIG. 8 is a schematic diagram of a liquid film formed on a container surface and entering pores in a cleaning method for a semiconductor storage container provided by an embodiment of the present disclosure;

[0090] FIG. 9 is a schematic flowchart of a cleaning method for a semiconductor storage container provided by a first aspect embodiment of the present disclosure;

[0091] FIG. 10 is a schematic flowchart of a cleaning method for a semiconductor storage container according to a specific embodiment of the first aspect of the present disclosure;

[0092] FIG. 11 is a schematic flowchart of a cleaning method for a semiconductor storage container according to another specific embodiment of the first aspect of the present disclosure;

[0093] FIG. 12 is a schematic flowchart of a cleaning method for a semiconductor storage container according to another specific embodiment of the first aspect of the present disclosure;

[0094] FIG. 13 is a schematic flowchart of a cleaning method for a semiconductor storage container provided by a second aspect embodiment of the present disclosure;

[0095] FIG. 14 is a flowchart of a cleaning method for a semiconductor storage container according to a specific embodiment of the second aspect of the present disclosure;

[0096] FIG. 15 is a flowchart of a cleaning method for a semiconductor storage container according to another specific embodiment of the second aspect of the present disclosure;

[0097] FIG. 16 is a schematic structural diagram of a cleaning system for a semiconductor storage container provided by an embodiment of the present disclosure;

[0098] FIG. 17 is a schematic flowchart of a cleaning method for a semiconductor storage container provided by a third aspect embodiment of the present disclosure;

[0099] FIG. 18 is a coordinate graph of gas pressure, AMC concentration and time in a second cleaning chamber in a cleaning method for a semiconductor storage container according to a specific embodiment of the third aspect of the present disclosure;

[0100] FIG. 19 is a schematic structural diagram of a cleaning system for a semiconductor storage container according to a specific embodiment of the third aspect of the present disclosure;

[0101] FIG. 20 is a schematic structural diagram of a positioning block 211 in a cleaning system for a semiconductor storage container according to a specific embodiment of the third aspect of the present disclosure;

[0102] FIG. 21 is a schematic diagram of gas flow direction in a second cleaning chamber during vacuumizing in a cleaning system for a semiconductor storage container according to a specific embodiment of the third aspect of the present disclosure;

[0103] FIG. 22 is a schematic structural diagram of a positioning block in a cleaning system for a semiconductor storage container according to another specific embodiment of the third aspect of the present disclosure;

[0104] FIG. 23 is a schematic flowchart of a cleaning method for a semiconductor storage container according to a specific embodiment of the third aspect of the present disclosure;

[0105] FIG. 24 is a schematic structural diagram of a cleaning system for a semiconductor storage container according to an embodiment of the third aspect of the present disclosure;

[0106] FIG. 25 is a schematic structural diagram of a cleaning system for a semiconductor storage container according to another embodiment of the third aspect of the present disclosure;

[0107] FIG. 26 is a schematic logic diagram of a cleaning method for a semiconductor storage container according to another embodiment of the third aspect of the present disclosure;

[0108] FIG. 27 is a coordinate graph of time and pressure in a second cleaning chamber in a cleaning method for a semiconductor storage container according to another embodiment of the third aspect of the present disclosure; and

[0109] FIG. 28 is a schematic flowchart of a cleaning method for a semiconductor storage container provided by a fourth aspect embodiment of the present disclosure.

[0110] a, container; a1, first cover body; a0, container surface; a01, pore; a11, lock hole; a12, first positioning hole; a2, cassette body; c, AMC contaminant; d, liquid film;

[0111] 1, first processing unit; 11, barrel body; 12, second cover body; 13, first positioning component; 131, suction cup; 132, first positioning block; 141, barrel-outer-wall spray pipe; 142, barrel-inner-wall spray pipe; 143, barrel-top spray pipe; 144, cover-outer-wall spray pipe; 145, cover-inner-wall spray pipe; 151, rotary rod; 1521, rotary drive member; 1522, rotary wheel; 1523, conveyor belt; 1524, linear drive member; 1525, first telescopic rod; 1526, bearing seat; 1527, bearing; 161, second positioning block; 171, first rotary disk; 172, second rotary disk;

[0112] 2, second processing unit; 20, second cleaning chamber; 21, chamber body; 211, positioning block; 211a, pad block; 2111, first support block; 2112, second support block; 22, chamber cover; 231, first heater; 232, second heater; and

[0113] 3, manipulator; 4, loading unit; 5, unloading unit.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0114] Exemplary embodiments of the present disclosure as disclosed herein will be described in detail below with reference to the drawings. It should be understood that the present disclosure can be implemented in various forms and should not be limited by the specific embodiments described herein. On the contrary, these embodiments are provided for a more thorough understanding of the present disclosure and to completely convey the scope of the present disclosure to those skilled in the art.

[0115] In the following description, numerous specific details are given to provide a more thorough understanding of the present disclosure. However, it will be apparent to those skilled in the art that the present disclosure can be practiced without one or more of these details. In other examples, in order to avoid confusion with the present disclosure, some well-known technical features are not described; that is, not all features of actual embodiments are described herein, and well-known functions and structures are not described in detail.

[0116] In the drawings, for clarity, dimensions of layers, regions, and elements and their relative dimensions may be exaggerated. Like reference numerals denote like elements throughout.

[0117] It should be understood that when an element or layer is referred to as being "on", "adjacent to", "connected to" or "coupled to" another element or layer, it can be directly on, adjacent to, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on", "directly adjacent to", "directly connected to" or "directly coupled to" another element or layer, there are no intervening elements or layers. It should also be understood that although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present disclosure. When discussing a second element, component, region, layer or section, this does not indicate that the present disclosure necessarily has a first element, component, region, layer or section.

[0118] Spatial relationship terms such as "under", "below", "lower", "beneath", "above", "upper" and the like may be used herein for ease of description to describe the relationship of one element or feature to another element(s) or feature(s) as illustrated in the figures. It should be understood that the spatial relationship terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "under" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary terms "below" and "under" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatial relationship terms used herein are interpreted accordingly.

[0119] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the present disclosure. As used herein, the singular forms "a", "an" and "the" are also intended to include the plural forms unless the context clearly indicates otherwise. It will be further understood that the terms "comprise" and/or "comprising", when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other

features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0120] In order to thoroughly understand the present disclosure, detailed steps and detailed structures will be set forth in the following description to explain the technical solutions of the present disclosure. Preferred embodiments of the present disclosure are described in detail below. However, in addition to these detailed descriptions, the present disclosure can also have other implementation manners.

[0121] For the semiconductor storage container involved in the embodiments of the present disclosure, the semiconductor storage container a (hereinafter sometimes referred to as "container") can be a semiconductor storage container for storing wafers, or can be a photomask storage box for storing photomasks, and of course can also be a storage box for other purposes. As shown in FIG. 1, the container a includes a separable cassette body a2 and a first cover body a1, and the container a further includes a locking mechanism. The cassette body a2 and the first cover body a1 are locked or unlocked through a knob assembly, that is, the knob assembly can realize a closed connection between the first cover body a1 and the cassette body a2, and can also realize separation of the first cover body a1 and the cassette body a2.

[0122] The embodiments of the present disclosure provide a cleaning system for a semiconductor storage container. As shown in FIG. 2, the cleaning system includes a loading unit 4, a first processing unit 1, a second processing unit 2, a detection unit, an unloading unit 5, a manipulator 3 and a frame. The loading unit 4, the first processing unit 1, the second processing unit 2, the detection unit, the unloading unit 5 and the manipulator 3 can have multiple units to form multiple stations, improving container processing efficiency. The loading unit 4 and the unloading unit 5 are adjacently arranged and located on the same side of the frame. The loading unit 4 is configured to load the container. The manipulator 3 is configured to transfer the container between various units. The first processing unit 1 is configured to perform a first cleaning process on the container. The second processing unit 2 is configured to perform a second cleaning process on the container. The detection unit is configured to detect a contaminant concentration level. The unloading unit 5 is configured to unload the container.

[0123] In an optional embodiment, the cleaning system is provided with a detection station, and the detection station is configured to detect the container and determine a contaminant condition inside the container.

[0124] In an optional embodiment, the detection station is arranged at the loading unit and configured to detect a contaminant condition inside the container before cleaning after loading, and determine whether the container can be sent for cleaning. If the contaminant content exceeds

a preset value, it indicates that the container cannot meet the cleaning qualification requirements after being processed by the cleaning system provided by the embodiments of the present disclosure, and at this time the equipment issues a warning signal, prompting removal of the container.

[0125] In an optional embodiment, the detection station is arranged at the unloading unit and configured to detect whether a contaminant residual level inside the container after cleaning completion meets process requirements.

[0126] In an optional embodiment, the detection unit includes an AMC online detection device (not shown in the figures), and the AMC online detection device can perform detection and analysis on gas passed therethrough, and in real-time obtain content of each component of the gas passed therethrough through PTR (Proton Transfer Reaction-mass spectrometry) and other methods, and determine a contaminant level of the gas passed therethrough.

[0127] The AMC online detection device in the present embodiment can perform mass spectrometry analysis on input gas in real time, and output content of each component of the input gas in real time. Further, the AMC online detection device in the present embodiment can simultaneously analyze content of at least 30 different components.

[0128] In an optional embodiment, the AMC online detection device is further connected to a first cleaning chamber and/or a second cleaning chamber, and the AMC online detection device detects and analyzes components of gas in the first cleaning chamber and/or the second cleaning chamber in real time. By comparing detection results with a set qualified range, it is determined whether an environment in the first cleaning chamber and/or the second cleaning chamber meets a requirement for cleaning the container. When the environment in the first cleaning chamber and/or the second cleaning chamber does not meet the cleaning requirement, cleaning of the container is stopped.

[0129] In an optional embodiment, the AMC online detection device can detect humidity level, acidic contaminants (acids, abbreviated as MA), alkaline contaminants (bases, abbreviated as MB), and condensable contaminants (condensables, abbreviated as MC) in the input gas.

[0130] In an optional embodiment, the detection results are a total AMC residual level.

[0131] In an optional embodiment, the detection results are residual levels of a plurality of different components, including inorganic ammonia, VOC, HF, SO_2, ACIDS, and AMINES.

[0132] In an optional embodiment, the detection results are a quantity and distribution of particles of a specific diameter.

[0133] In an optional embodiment, the AMC online detection device is connected to the first cleaning chamber, and through the AMC online detection device, a contaminant condition in the first cleaning chamber is analyzed to provide reference for subsequent cleaning processes.

[0134] In an optional embodiment, the AMC online detection device is connected to the second cleaning chamber, and through the AMC online detection device, a contaminant condition in the second cleaning chamber is analyzed to provide reference for subsequent cleaning processes.

[0135] In an optional embodiment, the AMC online detection device is connected to the detection station, and through the AMC online detection device, a contaminant condition inside the cleaned container is analyzed to provide basis for qualified unloading of the container.

[0136] In an optional embodiment, an output end of the AMC online detection device is connected to a control unit, and detection results are fed back to the control unit. The control unit determines a condition of residuals inside the container according to the feedback results, thereby selecting a next processing process for the container.

[0137] In the above embodiments, the control unit determines process parameters of equipment in the next processing process for the container according to the feedback results.

[0138] The embodiments of the present disclosure further provide a cleaning method for a semiconductor storage container, comprising step one, placing the container at the loading unit to complete loading of the container; step two, transferring the container to the first processing unit 1, and performing cleaning and drying on the container in the first processing unit; step three, transferring the container to the second processing unit 2, and utilizing a vacuum environment in the second processing unit to remove residual AMC contaminants inside the container and further dry the container; and step four, transferring the container to the unloading unit, and detecting the container in the unloading unit, and determining a subsequent processing mode according to detection results.

[0139] In an optional embodiment, the container in the loading unit is detected, and a subsequent processing mode is determined according to detection results.

[0140] In the first aspect, the embodiments of the present disclosure describe a cleaning system and a cleaning method for a semiconductor storage container.

[0141] Specifically, as shown in FIG. 3 to FIG. 5, a cleaning system for a semiconductor storage container provided by the embodiments of the present disclosure comprises a first processing unit 1, and the first processing unit 1 includes a barrel body 11, a second cover body 12, a knob assembly, a first positioning component 13, a spray assembly and a gas blowing assembly.

[0142] The second cover body 12 is hinged to the barrel body 11, and the second cover body 12 is covered on the barrel body 11 to form a space for cleaning the container a.

[0143] The knob assembly includes a rotary rod 151 and a first drive member, one end of the rotary rod 151 is connected to the first drive member, the first drive member is connected to the second cover body 12, and the rotary rod 151 is driven by the first drive member to penetrate through the second cover body 12 and be inserted into a lock hole a11 on the first cover body a1 to perform rotational movement. The rotary rod drives a lock body in the locking mechanism to rotate, so as to realize locking or unlocking of the first cover body a1 and the cassette body a2.

[0144] The first positioning component 13 is installed on the second cover body 12, and the first positioning component 13 is configured to connect the first cover body a1 to the second cover body 12.

[0145] The spray assembly includes a plurality of spray pipes, and the plurality of spray pipes are installed on side walls and/or a bottom wall of the barrel body 11. The plurality of spray pipes are configured to spray cleaning liquid to clean surfaces of the first cover body a1 and the cassette body a2.

[0146] The gas blowing assembly includes a plurality of gas blowing pipes, and the plurality of gas blowing pipes are installed on side walls and/or a bottom wall of the barrel body 11. After cleaning of the first cover body a1 and the cassette body a2 is completed, the plurality of gas blowing pipes blow gas onto surfaces of the first cover body a1 and the cassette body a2 to dry the first cover body a1 and the cassette body a2.

[0147] In the embodiments of the present disclosure, the knob assembly is utilized to unlock the cassette body a2 and the first cover body a1, and the first positioning component 13 is utilized to position the first cover body a1, so that the spray assembly and the gas blowing assembly can sufficiently clean the first cover body a1 and the cassette body a2, ensuring a cleaning degree.

[0148] In an optional embodiment, as shown in FIG. 4, the first drive member includes a rotary drive member 1521, a rotary wheel 1522, a linear drive member 1524 and a first telescopic rod 1525. The rotary wheel 1522 is connected to the rotary drive member 1521, one end of the first telescopic rod 1525 is connected to the linear drive member 1524, and the other end is connected to the rotary rod 151. The rotary rod 151 follows the rotary wheel 1522 to perform rotational movement under a driving force of the rotary drive member 1521, and the rotary rod 151 follows the first telescopic rod 1525 to perform reciprocating movement along a direction perpendicular to a surface of the second cover body 12 under a driving force of the linear drive member 1524, so as to be inserted into or pulled out from the lock hole a11 on the first cover body a1.

[0149] Furthermore, the first drive assembly further includes a bearing seat 1526 and a bearing 1527, the bearing seat 1526 is installed on the second cover body 12, the bearing seat 1526 is connected to the bearing 1527, and the rotary rod 151 penetrates through the bearing 1527 and the bearing seat 1526.

[0150] The first drive member further includes a conveyor belt 1523, the rotary wheel 1522 and the bearing 1527 are connected through the conveyor belt 1523, and the bearing 1527 follows the rotary wheel 1522 to perform rotational movement under a driving force of the rotary drive member 1521 to drive the rotary rod 151 to perform rotational movement, thereby rotating lock bodies on the first cover body a1 and the cassette body a2. The linear drive member 1524 is optionally driven by a cylinder, and the rotary drive member 1521 is optionally a rotary cylinder, but of course is not limited thereto.

[0151] In an alternative embodiment, the first drive member is a rotary pressing cylinder, and linear and rotational movement of the rotary rod is realized through the rotary pressing cylinder. The structure is simpler and the assembly is relatively simpler, thereby saving time and effort. Because it is a single cylinder, the stability is higher compared to a conventional arrangement requiring two cylinders to cooperate, and it is less prone to jamming. On the other hand, since only one cylinder is used, inspection and maintenance are convenient. For example, in a conventional arrangement, if a cylinder jams or a component is damaged, each component needs to be tested and inspected to find the damaged part, requiring longer repair time and longer equipment downtime, and when repairing after discovering a fault, more components need to be disassembled and replaced. In the present embodiment, if a component fails, maintenance can be achieved by directly replacing the entire component, the repair is simpler, the man-hours are shorter, and the resulting downtime is also shorter. Meanwhile, since it is a single cylinder, by evaluating the relationship between its usage frequency and lifespan, regular maintenance of this component can be performed to prevent component failure after long-term operation.

[0152] It should be noted that when the first drive member drives the rotary rod to be inserted into the lock hole and drives the lock body to perform unlocking or locking movement through rotation, the first drive member drives the rotary rod to reset, and the rotary rod is retracted.

[0153] In an optional embodiment, as shown in FIG. 3, the first positioning component 13 includes two suction cups 131, the suction cups 131 are connected to inner walls of the second cover body 12, and the two suction cups 131 are configured to be adsorbed on a surface of the first cover body a1 so that the first cover body a1 is parallel to the second cover body 12. Connection between the first cover body and the second cover body is achieved through the suction cups.

[0154] The first positioning component 13 further includes two first positioning blocks 132, the first positioning blocks 132 are connected to inner walls of the second cover body 12. When the suction cups 131 are adsorbed on the first cover body a1, the two first positioning blocks 132 correspond to first positioning holes a12 on the first cover body a1. The two first positioning blocks 132 can limit a position of the first cover body a1 on one hand, and on the other hand can provide support for the first cover body a1, ensuring that a distance between the suction cups and the first cover body is appropriate in position, improving stability of the first cover body a1 connected to the second cover body 12.

[0155] In an optional embodiment, as shown in FIG. 5, the spray assembly includes a barrel-outer-wall spray pipe 141, a barrel-inner-wall spray pipe 142, a cover-inner-wall spray pipe 145, a cover-outer-wall spray pipe 144 and a barrel-top spray pipe 143.

[0156] A plurality of barrel-outer-wall spray pipes 141 are connected to a periphery of a bottom wall of the barrel body 11, and after the cassette body a2 is inverted and installed in the barrel body 11, the plurality of barrel-outer-wall spray pipes 141 spray liquid onto outer walls of the barrel body 11 to rinse the outer walls of the barrel body 11. A plurality of barrel-inner-wall spray pipes 142 are connected to a middle position of the bottom wall of the barrel body 11, and after the cassette body a2 is inverted and installed in the barrel body 11, the plurality of barrel-inner-wall spray pipes 142 spray liquid onto inner walls of the barrel body 11 to rinse the inner walls of the barrel body 11. The barrel-top spray pipe 143 is adjacently arranged to the barrel-inner-wall spray pipe 142, and after the cassette body a2 is inverted and installed in the barrel body 11, the plurality of barrel-top spray pipes 143 spray liquid onto a top of the barrel body 11 (the top of the barrel body 11 is opposite to an opening of the barrel body 11) to rinse the top of the barrel body 11.

[0157] The cover-inner-wall spray pipe 145 and the cover-outer-wall spray pipe 144 are adjacently arranged, and one ends of the cover-inner-wall spray pipe 145 and the cover-outer-wall spray pipe 144 are connected to a side wall of the barrel body 11, and the other ends extend toward a middle position of the barrel body 11. When the second cover body 12 is covered on the barrel body 11, the cover-inner-wall spray pipe 145 and the cover-outer-wall spray pipe 144 are located at a side of the first cover body a1, and the cover-inner-wall spray pipe 145 and the cover-outer-wall spray pipe 144 spray liquid to respectively rinse an inner side surface and an outer side surface of the first cover body a1.

[0158] In the embodiments of the present disclosure, the barrel-outer-wall spray pipe 141, the barrel-inner-wall spray pipe 142, the cover-inner-wall spray pipe 145, the cover-outer-wall spray pipe 144 and the barrel-top spray pipe 143 are distributed at different positions and different

angles in the barrel body 11, so as to sufficiently rinse the first cover body a1 and the cassette body a2, improving a rinsing effect.

[0159] It should be noted that: when the cassette body a2 is inverted and installed on the bottom wall of the barrel body 11, an opening of the cassette body a2 and the bottom wall of the barrel body 11 have a space therebetween, and liquid sprayed by the spray assembly is discharged from a discharge port provided on the bottom wall of the barrel body 11, so as to discharge contaminants generated during the cleaning process out of the barrel body 11.

[0160] It should also be noted that the spray pipes are provided with a plurality of nozzles, and parameters such as the number of nozzles, nozzle spray directions, and spray pressure can be set according to specific conditions, which are not limited in the embodiments of the present disclosure.

[0161] In an optional embodiment, the gas blowing assembly includes a plurality of gas blowing pipelines (not shown in the figures), the gas blowing pipelines are configured to blow hot air, and the gas blowing pipelines are provided at the barrel-outer-wall spray pipe 141, the barrel-inner-wall spray pipe 142, the cover-inner-wall spray pipe 145, the cover-outer-wall spray pipe 144 and the barrel-top spray pipe 143 in the spray assembly.

[0162] That is, gas blowing pipelines are arranged at positions where spray pipes are arranged, and after rinsing is completed, the gas blowing pipelines are utilized to blow hot air onto the first cover body a1 and the cassette body a2 for drying, further improving a cleaning effect of the first cover body a1 and the cassette body a2.

[0163] In an optional embodiment, the second cover body is provided with an exhaust port (not shown in the figures) to discharge gas generated during the cleaning process out of the barrel body.

[0164] In an optional embodiment, liquid nozzles on the spray pipes can also be configured to deliver gas, that is, the gas blowing pipelines and the spray pipes are shared, which can reduce occupied space.

[0165] In an optional embodiment, the first processing unit 1 further includes a second positioning component, the second positioning component is installed on the bottom wall of the barrel body 11, and the second positioning component is configured to position the cassette body a2 on the barrel body 11, that is, the second positioning component is utilized to limit a position of the cassette body a2 in the barrel body 11.

[0166] Furthermore, as shown in FIG. 5, the second positioning component includes a plurality of second positioning blocks 161, the second positioning blocks 161 are connected to the bottom wall of the barrel body 11, and the second positioning blocks 161 match a plurality of second

positioning holes (not shown in the figures) provided on the cassette body a2. The plurality of second positioning holes are arranged at an opening of the cassette body a2, and the cassette body a2 is inverted and installed in the barrel body 11, that is, the opening of the cassette body a2 faces the bottom wall of the barrel body 11, and the second positioning holes match the second positioning blocks 161 to limit a position of the cassette body a2 in the barrel body 11.

[0167] In an optional embodiment, as shown in FIG. 3, the first processing unit 1 further includes a first rotary component. The first rotary component includes a first rotary motor (not shown in the figures) and a first rotary disk 171, the first rotary disk 171 is connected to the first rotary motor, the first positioning component 13 is connected to the first rotary disk 171, the first rotary motor is installed on an outer wall of the second cover body 12, the first rotary disk 171 is located on an inner wall of the second cover body 12, and the first rotary disk 171 is connected to the first cover body a1. The first cover body a1 follows the first rotary disk 171 to perform rotational movement under a driving force of the first rotary motor.

[0168] Furthermore, as shown in FIG. 5, the first processing unit 1 further includes a second rotary component, and the second rotary component includes a second rotary motor (not shown in the figures) and a second rotary disk 172. The second rotary disk 172 is connected to the second rotary motor, the second rotary motor is installed on an outer side of the bottom wall of the barrel body 11, the second rotary disk 172 is located at the bottom wall of the barrel body 11, and the second positioning component is connected to the second rotary disk 172. The cassette body a2 follows the second rotary disk 172 to perform rotational movement under a driving force of the second rotary motor.

[0169] In the above first processing unit 1, the first rotary component and the second rotary component are respectively utilized to drive the first cover body a1 and the cassette body a2 to perform rotational movement during the cleaning process and the blowing and drying process, so that the first cover body a1 and the cassette body a2 are cleaned and dried in all directions, improving cleaning sufficiency of the first cover body a1 and the cassette body a2.

[0170] In an optional embodiment, the first processing unit 1 further includes a cover drive member, one end of the cover drive member is connected to an outer wall of the second cover body 12, and the other end is connected to an outer wall of the barrel body 11. The second cover body 12 is covered on the barrel body 11 or moved away from an opening of the barrel body 11 under a driving force of the cover drive member, so as to realize closing or opening of the second cover body 12.

[0171] In an optional embodiment, the manipulator is utilized to move the semiconductor storage container to the second cover body 12, the manipulator drives the semiconductor storage

container to rotate at a certain angle so that the rotary rod is aligned with the lock hole, and through an action of the knob assembly, the locking mechanism is unlocked. Utilizing the manipulator to transport the semiconductor storage container reduces opportunities for the semiconductor storage container to be contaminated, while also improving a cleaning efficiency of the first processing unit 1.

[0172] In an optional embodiment, the first processing unit 1 further includes a heating component, and the heating component is installed on the barrel body 11 or the second cover body 12, and is configured to heat a first cleaning chamber formed by the barrel body 11 and the second cover body 12, so that the container a can be cleaned in an environment having a certain temperature. The higher the temperature, the easier AMC contaminants volatilize, improving a cleaning effect.

[0173] In an optional embodiment, the first processing unit 1 further includes a heating component, the heating component is installed on an air intake or liquid supply pipeline to heat gas or liquid in the pipeline, and the container a is cleaned using heated cleaning liquid or gas, improving a cleaning effect.

[0174] In the prior art, after the semiconductor storage container is placed in the first processing unit, preliminary cleaning of the semiconductor storage container is completed through cleaning liquid jet cleaning followed by CDA (Compress Dry Air) drying and the like.

[0175] The inventor has found through long-term research that through the above cleaning method, after AMC contaminants (hereinafter sometimes referred to as "AMC") are reduced to a certain level, it is difficult to further decrease, making it difficult to meet integrated circuit manufacturing process requirements. In particular, when the integrated circuit manufacturing process is further improved, for example, from 28nm to further below 14nm, 7nm or even 5nm, the control of all possible AMC pollution sources in the clean room reaches a very stringent level.

[0176] The embodiments of the present disclosure provide a cleaning method for a semiconductor storage container, and the cleaning method improves an AMC contaminant removal effect by first utilizing clean dry compressed gas to perform hot air blowing before using cleaning liquid to spray and clean the container.

[0177] A cleaning method for a semiconductor storage container provided by the embodiments of the present disclosure will be described in detail below with reference to the drawings. As shown in FIG. 9, the cleaning method comprises the following steps.

[0178] S12, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber.

[0179] The first cleaning chamber is a sealed space.

[0180] S13, blowing clean dry compressed gas onto a surface of the container at a fifth average volumetric flow rate for a duration T_{S13}.

[0181] In this step, when the container 1 is in a dry state, clean dry compressed gas is utilized to blow the container a. The dry compressed gas needs to be purified before blowing to reduce AMC and other contaminant content therein, thereby preparing clean dry compressed gas. This is mainly because using compressed dry gas containing more AMC and other contaminants may blow AMC and other contaminants therein onto the surface of the container a, thereby not only failing to reduce AMC content on the surface of the container a, but on the contrary possibly reducing a cleanliness level of the container a.

[0182] The purification process can be performed using a filter device having AMC and other contaminant adsorption capabilities.

[0183] S14, spraying cleaning liquid onto the surface of the container to clean the surface of the container.

[0184] In this step, cleaning liquid is sprayed onto a container surface a0 to rinse and dissolve most AMC contaminants on the container surface a0, further reducing an overall AMC contaminant content of the container a.

[0185] S15, blowing clean dry compressed gas onto the surface of the container.

[0186] This step utilizes clean dry compressed gas to dry the surface of the container a, thereby blow-drying a liquid film d existing on the surface of the container a, and reduce a humidity level in the container after cleaning.

[0187] It can be understood that, compared with existing container cleaning methods, the method provided by the embodiments of the present disclosure is based on blowing clean dry compressed gas before step S14, so that when a preliminary cleaning stage is completed, an AMC contaminant content of the container a is reduced, improving a cleaning effect on the container a.

[0188] The inventor has found in the process of committed development of an efficient AMC removal process for wafer storage containers that, since wafer storage containers are usually made of polymer materials such as PC, COPPC, CBM, and PEI, as shown in FIG. 6, during container molding, a certain number of pores a01 are formed on a container surface a0 due to manufacturing processes or material characteristics themselves, and after a certain period of use, the diameter and quantity of pores on the surface will increase to varying degrees. Furthermore, containers made of different materials have different pore sizes and quantities on the surface. During wafer processing, wafers having AMC contaminants c on the surface are stored in the container, and the AMC contaminants c may enter these pores a01 and accumulate.

[0189] In this case, when using existing cleaning methods to clean the container, that is, first using cleaning liquid to spray and clean, then using CDA to dry, as shown in FIG. 7, since cleaning liquid is sprayed on the container surface a0, a liquid film d is formed on the container surface a0, and during the process of blowing clean dry compressed gas using compressed dry air, the liquid film d affects removal of AMC contaminants c accumulated in the pores a01.

[0190] As shown in FIG. 8, although there is a situation where cleaning liquid enters the pores a01 and some AMC contaminants c in the pores a01 dissolve in the cleaning liquid, due to the small pore diameter of the pores a01, under capillary action, the cleaning liquid dissolving AMC contaminants c is also difficult to escape from the pores a01, making it difficult to carry AMC contaminants c out of the pores a01.

[0191] Furthermore, some gaseous AMC contaminants c may combine to form some contaminants insoluble in cleaning liquid when accumulating in the pores a01, and are difficult to be removed by cleaning liquid during the cleaning liquid cleaning stage. In the process of blowing the container a with clean dry compressed gas using compressed dry air, the generated hot air is mainly used to evaporate the liquid film d on the container surface a0, and when the liquid film d on the container surface a0 is dried, the cleaning liquid in the pores a01 of the container surface a0 can only be partially removed due to capillary action, and at this time, some AMC contaminants c and cleaning liquid still remain in the pores a01 of the container surface a0.

[0192] Therefore, before step S14, since the container surface a0 is not covered by the liquid film d, AMC contaminants c in the pores on the container surface a0 are easily detached under impact of rapid airflow. This is also the reason why in step S13, utilizing clean dry compressed gas to blow the container a can greatly improve the cleaning effect and reduce an AMC residual amount of the container.

[0193] In an optional embodiment, in step S13, the duration T_{S13} is a time from starting blowing until an AMC removal effect begins to decrease.

[0194] In an optional embodiment, in step S13, the duration T_{S13} is 10-80s, a fifth flow volume is 10000-240000 L, a supply pressure of the clean dry compressed gas is 0.5-1.2 MPa, and the fifth average volumetric flow rate is 1000-3000 LPM.

[0195] In an optional embodiment, the duration T_{S13} is 10-30s, the fifth flow volume is 12000-54000 L, the supply pressure of the clean dry compressed gas is 0.6-1.0 MPa, and the fifth average volumetric flow rate is 1200-1800 LPM. The applicant has determined through multiple experiments and tests that for most materials of containers, after 30s of blowing, an AMC contaminant residual amount on the surface tends to stabilize and will not further decrease due to an increase in blowing time.

[0196] In the above embodiments, an AMC level in the first cleaning chamber is detected through a detection device, and it is determined whether an AMC contaminant residual on the container surface tends to stabilize, thereby determining a range of the duration T_{S13}.

[0197] In an optional embodiment, an overall concentration of AMC contaminants in the gas after purification treatment is less than 10 ppbv.

[0198] In an optional embodiment, an overall concentration of AMC contaminants in the gas after purification treatment is less than or equal to 1 ppbv.

[0199] In an optional embodiment, for example, in a scheme with extremely strict AMC control, an overall concentration of AMC contaminants in the gas after purification treatment is controlled to be less than or equal to 0.1 ppbv.

[0200] In an optional embodiment, the gas after purification treatment can be CDA gas.

[0201] In an optional embodiment, dry compressed gas refers to gas having a relative humidity level below 0.5%.

[0202] In an optional embodiment, in step S13, a flow rate of clean dry compressed gas sprayed from each nozzle is controlled to be below 100 LPM; a higher blowing flow rate has a greater gas flow velocity, which easily forms vortices inside the container, and AMC contaminants blown away from the container surface easily accumulate in the vortices, which is not conducive to AMC discharge.

[0203] In an optional embodiment, in step S13, a flow rate of clean dry compressed gas sprayed from each nozzle is controlled to be 10-50 LPM.

[0204] In an optional embodiment, in step S14, a cleaning time is 10-40s, a cleaning liquid supply pressure is 0.2-0.6 MPa, and a cleaning liquid supply flow rate is 10-40 LPM.

[0205] In an optional embodiment, in step S14, a cleaning time is 20-30s, a cleaning liquid supply pressure is 0.3-0.5 MPa, and a cleaning liquid supply flow rate is 15-25 LPM.

[0206] In an optional embodiment, in step S14, the cleaning liquid is deionized water (DIW).

[0207] In an optional embodiment, in step S15, a blowing time is 150-400s, a supply pressure of the clean dry compressed gas is 0.5-2.0 MPa, and a supply flow rate of the clean dry compressed gas is 1000-4000 LPM.

[0208] In an optional embodiment, in step S15, a blowing time is 200-300s, a supply pressure of the clean dry compressed gas is 0.6-1.6 MPa, and a supply flow rate of the clean dry compressed gas is 1200-3500 LPM.

[0209] In an optional embodiment, as shown in FIG. 10, before step S13, the cleaning method further comprises step S10:

[0210] connecting the first cover body to the second cover body, and unlocking the first cover body and the cassette body, wherein the container includes the first cover body and the cassette body.

[0211] Specifically, the container is grabbed and transferred by the manipulator, the container is pressed against the second cover body, the first cover body is positioned by the first positioning component, the knob assembly extends into a lock hole of the first cover body and rotates to unlock the first cover body a1 and the cassette body a2, and the container a includes the first cover body a1 and the cassette body a2.

[0212] The first cover body a1 is connected to an inner wall of the second cover body 12 of the first processing unit 1, the second cover body 12 is connected to the barrel body 11 of the first processing unit 1, and the second cover body 12 is covered on the barrel body 11 to form a space for cleaning the container a. When the first cover body a1 is connected to the inner wall of the second cover body 12, an outer wall of the first cover body a1 faces the inner wall of the second cover body 12. When the second cover body 12 is covered on the barrel body 11, a plane where the first cover body a1 is located is parallel to a horizontal plane.

[0213] In this step, the first cover body a1 and the cassette body a2 in a locked state are unlocked, that is, the first cover body a1 and the cassette body a2 are allowed to be separated. Separating the first cover body a1 and the cassette body a2 enables sufficient cleaning of both, improving a cleaning effect.

[0214] In an optional embodiment, before step S13, the cleaning method further comprises step S11:

[0215] inverting the cassette body and placing it in the barrel body, and covering the second cover body on the barrel body to form a sealed first cleaning chamber for cleaning the container.

[0216] The cleaning method provided by the embodiments of the present disclosure further comprises pressing the cleaned cassette body against the first cover body and locking the first cover body and the cassette body.

[0217] Specifically, after the cassette body is pressed against the first cover body, the knob assembly extends into a lock hole of the first cover body and rotates to close the semiconductor storage container.

[0218] In an optional embodiment, in step S13, step S14 and step S15, an ambient temperature in the first cleaning chamber in the first processing unit 1 is greater than or equal to 40 °C and less than or equal to 80 °C.

[0219] An ambient temperature greater than or equal to 40 °C and less than or equal to 80 °C can improve volatility of AMC contaminants, thereby promoting discharge of AMC contaminants.

[0220] In an optional embodiment, the temperature of clean dry compressed gas in step S13 and step S15 is greater than or equal to 40 °C and less than or equal to 80 °C.

[0221] Clean dry compressed gas greater than or equal to 40 °C and less than or equal to 80 °C can promote volatilization and detachment of AMC contaminants on the surface of the container a and in surface pores a01 thereof, thereby reducing an overall AMC contaminant content of the container a. At the same time, it will not cause the container to overheat and deform.

[0222] In an optional embodiment, the temperature of cleaning liquid in step S14 is greater than or equal to 50 °C and less than or equal to 70 °C. Cleaning liquid greater than or equal to 50 °C and less than or equal to 70 °C more easily dissolves AMC contaminants, further reducing an AMC contaminant content on the surface of the container a. Since liquid has higher specific heat, cleaning liquid less than or equal to 70 °C will not cause the container to overheat and deform.

[0223] In an optional embodiment, during the cleaning process, that is, in step S13, step S14 and step S15, the first cover body a1 and the cassette body a2 perform rotational movement.

[0224] Blowing and cleaning liquid spraying are performed on the first cover body a1 and the cassette body a2 in rotational movement. On one hand, this can increase a contact area between the surface of the container a and the cleaning liquid and the clean dry compressed gas, improving a blowing effect and a rinsing effect. On the other hand, this ensures uniformity of blowing and spray cleaning, ensuring that every part of the container is covered.

[0225] In an optional embodiment, as shown in FIG. 11, the clean dry compressed gas and the cleaning liquid share the same supply system, and step S15 further comprises the following steps.

[0226] S151, blowing clean dry compressed gas onto the surface of the container for a duration T_{S151} to remove residual cleaning liquid in a pipeline. In this step, clean dry compressed gas is blown onto the surface of the container to blow out residual cleaning liquid in the pipeline, avoiding a dripping phenomenon at nozzles during a subsequent blowing process, which would affect a drying effect.

[0227] S152, blowing clean dry compressed gas onto the surface of the container for a duration T_{S152}. The cleaning liquid of the surface of the container is rapidly dried by blowing clean dry compressed gas onto the surface of the container.

[0228] A flow rate of the clean dry compressed gas blown onto the surface of the semiconductor storage container in step S151 is greater than a flow rate of the clean dry

compressed gas blown onto the surface of the semiconductor storage container in step S152; and the duration T_{S151} is less than the duration T_{S152}.

[0229] In the above embodiments, in step S151, the duration T_{S151} is 5-40s, a supply pressure of the clean dry compressed gas is 0.7-2.0 MPa, a supply flow rate of the clean dry compressed gas is 1500-3500 LPM. In this stage, clean dry compressed gas is blown for a short time at a large flow rate, so that cleaning liquid remaining in the pipeline in step S14 is blown out, avoiding a dripping phenomenon at nozzles during a subsequent blowing process, which would affect a drying effect. In step S152, the duration T_{S152} is 150-400s, a supply pressure of the clean dry compressed gas is 0.5-1.2 MPa, a supply flow rate of the clean dry compressed gas is 1200-1800 LPM, and a temperature of supplied clean dry compressed gas is between 40-80 °C. The cleaning liquid on the container is rapidly dried by blowing clean dry compressed gas onto the surface of the container.

[0230] In an optional embodiment, in step S152, the clean dry compressed gas is heated to 40-80 °C.

[0231] In an optional embodiment, as shown in FIG. 12, the cleaning method further comprises the step of:

[0232] S16, during the container cleaning process, detecting gas discharged from the first cleaning chamber.

[0233] Evaluation of an effect of removing AMC by blowing with clean compressed dry gas and confirmation of a blowing end time can be performed by utilizing an AMC online detection device to detect AMC concentration in gas discharged from the first processing unit 1. At the beginning of blowing, since AMC particles on the container surface are continuously blown away from the container surface and discharged by compressed dry gas, the AMC concentration detected by the AMC online detection device will maintain at a relatively high level and show fluctuating changes. As most AMC contaminants are blown out from the container by compressed dry gas, the AMC concentration detected by the AMC online detection device begins to gradually decrease, and then tends to a relatively low level. It can be understood that stopping blowing the container a with gas in step S13 when the AMC removal effect begins to decrease can ensure to the greatest extent the efficiency of clearing AMC contaminants on the inner wall of the container during blowing.

[0234] On the other hand, a main purpose of a gas blowing process after cleaning liquid cleaning is to remove moisture on the container surface, thereby reducing a humidity level in the container. Therefore, when the humidity level in the first cleaning chamber decreases to a reasonable range, gas blowing in step S15 can be stopped.

[0235] In an optional embodiment, the cleaning method further comprises the step of:

[0236] after the container completes cleaning and is removed from the first cleaning chamber, cleaning the first cleaning chamber to remove residual contaminants in the first cleaning chamber.

[0237] After the container completes cleaning, the container is removed from the first cleaning chamber. Cleaning liquid is sprayed into the first chamber and the first chamber is cleaned, and then the first cleaning chamber is blown with clean dry compressed gas to remove residual contaminants in the first cleaning chamber. When a next container to be cleaned is placed in the first cleaning chamber for cleaning, contamination of the container by residual contaminants in the first cleaning chamber can be avoided, which would affect the cleaning effect.

[0238] In the second aspect, the embodiments of the present disclosure further provide a cleaning method of the semiconductor storage container, a cleaning unit and a cleaning system based on detection results. As shown in FIG. 13, the cleaning method comprises the following steps.

[0239] S31, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber.

[0240] S32, cleaning the container in the first cleaning chamber using cleaning liquid.

[0241] Cleaning liquid is sprayed on the surface of the container to clean the container.

[0242] S33, detecting contaminants in the first cleaning chamber to obtain detection results, wherein the types of detected contaminants include particles and/or AMC.

[0243] A contaminant level in the first cleaning chamber is determined by detecting gas discharged from the first cleaning chamber through a detection device, so as to determine a cleaning condition of the container inside the first cleaning chamber.

[0244] S34, performing subsequent processing according to the detection results.

[0245] The first cleaning chamber is connected to a first detection unit, the first detection unit is configured to detect a contaminant level in the first cleaning chamber and can obtain detection results in real time. The detection device feeds the detection results back to a first control unit, and the first control unit determines subsequent processing for the container according to the detection results. The detection results are determined according to process-required container index conditions. By detecting the first cleaning chamber, a contaminant level inside the container can be indirectly reflected, thereby providing data reference for subsequent processing, so as to select a reasonable processing mode, optimize a processing flow, and improve processing efficiency, and also improve a pass rate of processed containers.

[0246] In an optional embodiment, detection items for gas in the first detection unit include particulate matter, humidity level, acidic contaminants (acids, abbreviated as MA), alkaline contaminants (bases, abbreviated as MB), and condensable contaminants (condensables, abbreviated as MC).

[0247] In an optional embodiment, in step S33, the AMC includes one or more of SO_2, inorganic ammonia, VOC, organic amines, and acids.

[0248] In an optional embodiment, the cleaning method further comprises setting process parameters of a cleaning system in subsequent processing according to the detection results.

[0249] Since each container has a different contaminant residual level before processing, and after undergoing a fixed processing flow, its contaminant residual level is also different, and for different materials, an efficiency of each processing step in removing contaminants is also different. According to a contaminant residual level after processing of each container, subsequent processing parameters for each container are determined, processing resources are reasonably allocated, a pass rate of container cleaning is ensured, and processing efficiency of containers can also be improved.

[0250] In an optional embodiment, in step S34, the cleaning method comprises: a subsequent processing mode includes transferring a container that has completed cleaning in the first cleaning chamber to the second cleaning chamber for processing, and setting process parameters of the second cleaning chamber according to the detection results.

[0251] In an optional embodiment, the subsequent processing mode further includes transferring the container to the unloading unit. In this embodiment, after cleaning in the first cleaning chamber, a contaminant residual level inside the container already meets a qualified unloading standard, so processing in the second cleaning chamber is not required, and the container can be directly unloaded.

[0252] In an optional embodiment, the subsequent processing mode includes re-cleaning the container in the first cleaning chamber. In this embodiment, after cleaning in the first cleaning chamber, a contaminant residual level inside the container is still at a relatively high level. According to a processing capability of the second cleaning chamber, a container type, and a contaminant residual level required for the cleaned container by the process, it is comprehensively determined that after cleaning in the second cleaning chamber, the contaminant residual level inside the container still cannot meet a qualified unloading standard. Therefore, secondary cleaning needs to be performed in the first cleaning chamber, so that the contaminant residual level inside the container is reduced to a reasonable range.

[0253] In an optional embodiment, the subsequent processing mode further includes removing the container from the first cleaning chamber. In this embodiment, after cleaning in the first cleaning chamber, a contaminant residual level inside the container is still in a seriously excessive state, and the container needs to be re-cleaned in the first cleaning chamber. However, according to the processing capability of the first cleaning chamber, the container type, and the contaminant residual level required for the container after cleaning in the second cleaning chamber by the process, it is comprehensively determined that even if the container undergoes secondary cleaning in the first cleaning chamber, the contaminant residual level inside the container still cannot be reduced to a reasonable range, that is, after cleaning of this container in the second cleaning chamber, the qualified unloading standard cannot be met. At this time, it is determined that the cleaning system cannot clean this container, and the container needs to be removed.

[0254] In an optional embodiment, step S33 comprises:

[0255] setting a first preset threshold according to process parameters, and determining whether the detection results are below the first preset threshold.

[0256] If yes, the container completes a cleaning operation, and the container is placed in a vacuum drying chamber for further cleaning operation, that is, the following second cleaning chamber performs vacuum drying treatment.

[0257] If no, step S32 is repeated.

[0258] In an optional embodiment, step S33 further comprises:

[0259] setting a second preset threshold according to process parameters, and determining whether the detection results are higher than the second preset threshold, wherein the second preset threshold is higher than the first preset threshold.

[0260] If yes, an alarm signal is issued. When the detection results are greater than the second preset threshold, the container contaminant exceeds a standard. In this case, the processing capability of the first processing chamber is insufficient to complete cleaning of the container, and at this time the container is not suitable for continued cleaning in the cleaning system. By promptly identifying containers with relatively high contaminant residual levels and issuing a warning, a pass rate of the entire cleaning equipment for container cleaning can be improved.

[0261] In the embodiments of the present disclosure, both the first preset threshold and the second preset threshold can be set comprehensively according to the cleaning processing capability of the first cleaning chamber, the container type, and the process-required container index conditions.

[0262] In an optional embodiment, multiple sub-thresholds can also be set between the first preset threshold and the second preset threshold, so that corresponding preset cleaning procedures can be selected according to different sub-thresholds.

[0263] In an optional embodiment, the first preset threshold is a qualified value for the container after completing cleaning in the first cleaning chamber according to process requirements, that is, when the contaminant level in the first cleaning chamber is below the first preset threshold, the container therein can meet final process requirements after selecting a preset cleaning procedure for cleaning in the following second cleaning chamber.

[0264] The second preset threshold is set comprehensively according to the cleaning processing capability of the first cleaning chamber, the container type, and the process-required container index conditions. When the contaminant level in the first cleaning chamber is higher than the second preset threshold, it indicates that after cleaning of the container in the first cleaning chamber, the contaminant residual level inside the container cannot meet the requirements set by the process.

[0265] It should be noted that when the contaminant level in the first cleaning chamber is below the first preset threshold, this only indicates that after the container fully undergoes subsequent process flows, the contaminant residual level inside the container can meet final contaminant control requirements, and does not mean that when the contaminant residual level in the first cleaning chamber is below the first preset threshold, the container therein can be qualified for unloading.

[0266] In an optional embodiment, the first preset threshold is a total AMC content of 200 ppbv; and the second preset threshold is a total AMC content of 5000 ppbv.

[0267] In an optional embodiment, the first preset threshold is an inorganic ammonia content of 25 ppbv, a VOC content of 200 ppbv, an HF content of 6500 pptv, an SO_2 content of 400 pptv, an ACIDS content of 4000 pptv, and an AMINES content of 5000 pptv; and the second threshold is an inorganic ammonia content of 1500 ppbv, a VOC content of 3500 ppbv, an HF content of 1000 ppbv, an SO_2 content of 700 ppbv, an ACIDS content of 850 ppbv, and an AMINES content of 350 ppbv.

[0268] In an optional embodiment, step S33 further comprises:

[0269] setting a qualified unloading threshold for the first cleaning chamber, wherein the qualified unloading threshold is below the first preset threshold, determining whether the detection results are below the qualified unloading threshold, and when contaminants in the container are below the qualified unloading threshold, transferring the cleaned container to the

unloading unit, wherein the qualified unloading threshold of the first cleaning chamber is below the first preset threshold.

[0270] The qualified unloading threshold of the first cleaning chamber corresponds to that when the contaminant level in the first cleaning chamber meets this threshold, the corresponding cleaned container can meet contaminant control requirements for final unloading of the container.

[0271] In an optional embodiment, as shown in FIG. 14, after step S33, the cleaning method further comprises the following step:

[0272] S35, after completing cleaning of the container and removing the container from the first cleaning chamber, cleaning the first cleaning chamber. During the process of cleaning the container in the first cleaning chamber, contaminants remaining inside the container will more or less remain in the first cleaning chamber. If not cleaned in time, these residual contaminants will affect containers subsequently cleaned. Therefore, after the container is removed from the first cleaning chamber, the first cleaning chamber needs to be cleaned to reduce its internal contaminant residual level to better clean subsequent containers.

[0273] In an optional embodiment, as shown in FIG. 15, after step S35, the cleaning method further comprises step of:

[0274] S36, after the container is removed from the first cleaning chamber, detecting a contaminant level in the first cleaning chamber, and determining whether the first cleaning chamber can continue to clean containers.

[0275] In the above embodiments, a preset value of the contaminant level is set according to process parameters of the first processing unit. If a detected value of the contaminant level exceeds the preset value, the equipment issues a warning signal to prompt that equipment maintenance is required. It should be noted that this preset value is a requirement for a contaminant level in the cleaning environment in the process step of the present embodiment, that is, the container needs to be cleaned in an environment where the contaminant level is below the preset value.

[0276] After completing cleaning of the first cleaning chamber, a contaminant level in the first cleaning chamber is detected. If the contaminant level in the first cleaning chamber exceeds the preset value, it indicates that the environment in the first cleaning chamber is no longer suitable for cleaning containers. Cleaning containers in a first cleaning chamber with excessive contaminants will have an adverse effect on cleaning of the containers, and continuing to clean will reduce a pass rate of container cleaning. Therefore, the equipment needs to be shut down for maintenance.

[0277] In an optional embodiment, the cleaning method further comprises: before the first cleaning chamber cleans the container, detecting a contaminant residual level inside an uncleaned container, and when the detection results are below or equal to a fifth preset threshold, cleaning the container according to the steps in the above embodiments. When the detection results are higher than the fifth preset threshold, the first control unit issues a prompt, indicating that a contaminant level in the container is relatively high and is not suitable for direct cleaning in the first cleaning chamber. The fifth preset threshold is set comprehensively according to the cleaning processing capability of the first cleaning chamber, the container type, and the process-required container index conditions. When a container with a residual level higher than the fifth preset threshold continues to be cleaned in the first cleaning chamber, residual contaminants inside the container will contaminate components in the entire equipment, and when the cleaning system cleans subsequent containers, the subsequent containers will be contaminated. Therefore, continuing to clean a container with a contaminant residual level exceeding the fifth preset threshold may affect a pass rate of cleaning in the first cleaning chamber. Therefore, when the first control unit issues a prompt, a decision on the next processing mode is made by on-site technical personnel after judgment.

[0278] The embodiments of the present disclosure further provide a cleaning unit adopting any one of the cleaning methods provided in the above embodiments.

[0279] The embodiments of the present disclosure further provide a cleaning system for a semiconductor storage container, comprising the above cleaning unit, wherein the cleaning unit includes a first cleaning chamber configured to accommodate the container, a spray assembly, a first control unit and a first detection unit.

[0280] The spray assembly is connected to the first cleaning chamber and configured to spray cleaning liquid. The first detection unit is connected to the first cleaning chamber and configured to detect gas discharged from the first cleaning chamber. The first detection unit and the spray assembly are electrically connected to the first control unit. The first detection unit feeds detection results back to the first control unit, and the first control unit sends instructions to the spray assembly after processing and analyzing received detection results. The spray assembly adjusts process parameters based on the detection results to improve cleaning efficiency of the container.

[0281] In an optional embodiment, the cleaning system further includes an alarm, the alarm is electrically connected to the first detection unit, and when detection results of the first detection unit show excess, the alarm receives an alarm instruction and issues an alarm.

[0282] In the third aspect, the embodiments of the present disclosure describe a cleaning unit, a cleaning system and a cleaning method for a semiconductor storage container.

[0283] After cleaning the container using the cleaning method provided in the above embodiments, moisture, cleaning liquid not dried in pores on side walls of the container, and some AMC contaminants may still remain on the container surface. To further reduce an AMC level in the container, for example, to meet further improvement of the integrated circuit manufacturing process, a maximum size of AMC contaminants needs to meet requirements of below 14nm, 7nm or even 5nm.

[0284] Specifically, as shown in FIG. 16, a second processing unit 2 for a semiconductor storage container provided by the embodiments of the present disclosure includes a second cleaning chamber 20, and a vacuum pump is connected to an outer side of the second cleaning chamber 20. The vacuum pump extracts gas from the second cleaning chamber 20 to place the second cleaning chamber 20 in a vacuum state. The vacuum pump is connected to a flow meter, and a flow rate of extracted gas is adjusted using the flow meter. A power of the vacuum pump changes in real time according to the flow rate of extracted gas adjusted by the flow meter, that is, a vacuum pump at different extraction power levels takes different times to complete gas extraction from the second cleaning chamber 20, and a gas volumetric flow rate extracted per unit time is different. The pressure detection member is connected to the second cleaning chamber, and the pressure detection member is configured to detect a pressure in the second cleaning chamber.

[0285] In an optional embodiment, the second processing unit 2 further includes a vacuum breaking component, the vacuum breaking component is connected to an outer side of the second cleaning chamber and configured to input inert gas or nitrogen gas into the second cleaning chamber to restore a pressure in the second cleaning chamber to a relatively high state, such as, atmospheric pressure state.

[0286] In an optional embodiment, the vacuum pump and the second cleaning chamber are connected through a first valve, and the vacuum breaking component and the second cleaning chamber are connected through a second valve. When the vacuum pump performs a vacuumizing operation on the second cleaning chamber, the first valve is opened and the second valve is closed. When the vacuum breaking component performs a gas filling operation on the second cleaning chamber, the first valve is closed and the second valve is opened.

[0287] The embodiments of the present disclosure further provide a cleaning method for a semiconductor storage container. As shown in FIG. 17, the cleaning method comprises the following steps.

[0288] S21, placing a cleaned container in a second cleaning chamber.

[0289] S22, vacuumizing the second cleaning chamber for a duration T_{S22}, so that a pressure in the second cleaning chamber is less than or equal to a first preset pressure value, and maintaining a temperature in the second cleaning chamber between 40-80 °C. When the second cleaning chamber is in a sealed state, the second cleaning chamber is vacuumized so that a pressure in the second cleaning chamber is reduced to a relatively low negative pressure, that is, below the first preset pressure value. In a low-pressure state, trigger conditions for volatilization of residual moisture on the container surface, cleaning liquid not dried in surface pores of the container, and AMC contaminants are lowered, AMC contaminants on the container surface easily volatilize, and an AMC contaminant content in the container is also reduced.

[0290] In this step, since the surface of the container has a large number of pores, most AMC contaminants remain inside the pores, and by reducing a pressure in the second cleaning chamber, a pressure difference is formed at the pores, and AMC inside the pores is more easily volatilized. It can be understood that the greater the pressure difference between the container and the vacuum chamber, the better the AMC contaminant removal effect.

[0291] As shown in FIG. 18, within time t1, a pressure 310 in the second cleaning chamber continuously decreases. As the pressure 310 decreases, AMC contaminants on the container surface diffuse into the second cleaning chamber, and an AMC contaminant concentration 320 in the second cleaning chamber shows an upward trend.

[0292] The lower the pressure in the second cleaning chamber, the more difficult it is to further reduce the internal pressure. After the vacuum pump works for a period of time, the pressure in the second cleaning chamber cannot continue to decrease, and its pressure value is in an equilibrium state. Correspondingly, a volatilization rate of AMC contaminants in the container will also show a gradual slowing trend. After a period of time, as shown at time t1 in FIG. 18, a content of residual AMC contaminants in the container and an AMC contaminant concentration in the second cleaning chamber will also maintain a stable state (that is, a so-called first equilibrium state hereinafter), which is also why after the container undergoes a conventional drying process, an AMC contaminant concentration in the container is still in a relatively high range.

[0293] S23, filling the second cleaning chamber with gas at a first average volumetric flow rate for a duration T_{S23}, and maintaining a maximum pressure value in the second cleaning chamber during step S23 to be less than or equal to a second preset pressure value, wherein the gas is clean dry compressed gas.

[0294] When the pressure in the second cleaning chamber is less than or equal to the first preset pressure value, gas is filled into the second cleaning chamber. The filled gas replaces AMC contaminants in the pores to achieve the purpose of removing AMC contaminants in the pores.

[0295] S24, filling the second cleaning chamber with gas at a second average volumetric flow rate for a duration T_{S24}, and maintaining a maximum pressure value in the second cleaning chamber during step S24 to be less than or equal to a third preset pressure value, wherein the gas is clean dry compressed gas. In step S23, a gas supply flow rate of the vacuum breaking component is less than a gas supply flow rate of the vacuum breaking component in step S24, that is, the first average volumetric flow rate is less than the second average volumetric flow rate. The maximum pressure value in the second cleaning chamber during step S23 is less than the maximum pressure value in the second cleaning chamber during step S24.

[0296] In the present embodiment, the first preset pressure value, the second preset pressure value, and the third preset pressure value are all set comprehensively according to a cleaning processing capability of the second cleaning chamber, a container type, and process-required container index conditions.

[0297] It can be understood that, before filling a small flow rate of gas into the second cleaning chamber, the second cleaning chamber is vacuumized, the pressure in the chamber continuously decreases, and the gas concentration also continuously decreases. AMC contaminants in surface pores of the container are driven by pressure and continuously diffuse from inside the pores into a gas boundary layer near the container surface. As the pressure in the chamber tends to stabilize, at this time the pressure in the second cleaning chamber is in a medium-to-low vacuum range, but at this time an average free path of gas molecules in the chamber is still relatively short compared to the size of the second cleaning chamber. At this time, a distinct gas boundary layer is still formed on the container surface. The existence of such a gas diffusion layer affects diffusion of AMC contaminants in the surface pores of the container into other regions of the second cleaning chamber. As the pressure in the chamber tends to stabilize, gas flow in the chamber decreases, and flow of the gas boundary layer near the container surface also gradually decreases. A diffusion process of AMC contaminants in the surface pores of the container toward the gas boundary layer near the container surface gradually establishes equilibrium, so a removal rate of AMC contaminants in the surface pores of the container also gradually slows. That is, a so-called second equilibrium state hereinafter, and when the second cleaning chamber is in the second equilibrium state, an AMC contaminant residual amount on the container surface will not decrease as the amount of filled gas increases.

[0298] At this time, a small flow rate of gas is filled into the second cleaning chamber, and the second chamber is maintained in a negative pressure state (a pressure in the second cleaning chamber is several thousand Pa). Filled gas molecules are driven by a pressure gradient and diffuse into the boundary layer near the container surface, thereby reducing an AMC contaminant concentration in the boundary layer near the container surface, breaking the previously established diffusion equilibrium, promoting further accelerated diffusion of AMC in the surface pores of the container into the boundary layer, and further reducing an amount of AMC contaminants in the surface pores of the container.

[0299] Furthermore, the filled small flow rate of gas, when flowing to the container surface, accelerates flow of the boundary layer near the container surface, which can further help remove AMC contaminants desorbed from the container surface or the pores.

[0300] Further, the filled small flow rate of gas also helps produce a slight pressure change near the container surface, which also helps break the diffusion equilibrium of AMC contaminants near the surface pores of the container, thereby promoting AMC contaminants in the pores to diffuse outward.

[0301] Furthermore, in step S24, when gas is filled at the second average volumetric flow rate, the filled gas forms a flow field in the container. AMC contaminants remaining near the surface region of the container in step S23 are carried away from the surface of the container by the flow field generated by the gas, avoiding re-attachment of AMC contaminants to the surface of the container.

[0302] In the embodiments of the present disclosure, when a larger volumetric flow rate of gas is rapidly filled into the second cleaning chamber, a larger pressure gradient and concentration gradient can be formed near the surface pores of the container. Nitrogen gas molecules or inert gas molecules enter the pores at a higher speed, while flushing out AMC originally located in the pores. By filling a larger volumetric flow rate of gas into the second cleaning chamber, an AMC removal effect can be improved.

[0303] Furthermore, when a larger volumetric flow rate of gas is rapidly filled, the pressure in the second cleaning chamber increases, and the temperature in the second cleaning chamber also increases accordingly. The temperature increase can improve activity of AMC Brownian motion, which is conducive to volatilization of AMC, further improving an AMC removal effect.

[0304] In an optional embodiment, the second preset pressure value is 5000 Pa.

[0305] In a preferred embodiment, the second preset pressure value is 2000 Pa.

[0306] In an optional embodiment, the third preset pressure value is one standard atmospheric pressure, that is, 101 kPa.

[0307] In an optional embodiment, the gas filled in step S23 and step S24 is nitrogen gas and/or inert gas.

[0308] In the above embodiments, in the process of step S24, the filled gas adheres to the surface of the container, forming a protective layer on the container surface to isolate the container surface from the external environment, thereby avoiding direct contact between the external environment and the container surface, which would cause oxidation of the container surface, and thus affect the cleaning effect of the container.

[0309] In the above embodiments, the second preset pressure value is 10-40 times the first preset pressure value.

[0310] In an optional embodiment, step S21 specifically comprises: placing a semiconductor storage container cleaned in the above embodiments in a second cleaning chamber 20. The second cleaning chamber 20 includes a chamber cover 22 and a chamber body 21, the chamber cover 22 is covered on the chamber body 21 to form a space for drying the container. The chamber cover 22 is opened to place the container in the second cleaning chamber body 21, and the chamber cover 22 is covered on the chamber body 21, so that the second cleaning chamber is in a sealed state.

[0311] In an optional embodiment, the duration T_{S22} is 40-250s, and the first preset pressure value is less than or equal to 300 Pa. In an optional embodiment, the duration T_{S22} is 10-300s, and the first preset pressure value is less than or equal to 100 Pa. Under lower pressure conditions, AMC contaminants attached to the container surface and in the gas are more easily volatilized.

[0312] In an optional embodiment, the first preset pressure value is 100 Pa.

[0313] In an optional embodiment, after step S24, the cleaning method further comprises step S25: in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than or equal to a minimum pressure value in the second cleaning chamber in the previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than or equal to a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

[0314] In this step, the number of cycles is determined according to different process parameters. The higher the requirement for an AMC residual level of the container, the more the number of cycles. Furthermore, the number of cycles is set in a range of 3-10 number of times.

[0315] In an optional embodiment, in each cycled step S22, a minimum pressure value in the second cleaning chamber is equal to a minimum pressure value in the second cleaning chamber in the previous execution of step S22, and/or a duration of vacuumizing the second cleaning

chamber is equal to a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

[0316] Through multiple cycles, when the second cleaning chamber is again in a negative pressure state, at this time an AMC contaminant concentration on the container surface is higher than an AMC contaminant concentration in the second cleaning chamber, so AMC contaminants on the container surface will further diffuse into the second cleaning chamber, and an AMC contaminant residual on the container surface is further reduced.

[0317] In an optional embodiment, in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than a minimum pressure value in the second cleaning chamber in the previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

[0318] Through multiple cycles of vacuumizing, and compared to the previous cycle, performing rapid vacuumizing with a larger flow rate, by increasing an extraction flow rate, a time required to reach the preset pressure is reduced, and by extracting to a lower pressure value, a larger pressure gradient is formed near the surface pores of the container. AMC contaminants in the pores can be further released under an environment with larger pressure and concentration gradients, thereby further removing an AMC contaminant residual on the container surface.

[0319] In an optional embodiment, in each cycled step S22, a minimum pressure value in the second cleaning chamber and/or a duration of vacuumizing the second cleaning chamber are set comprehensively according to a cleaning processing capability of the second cleaning chamber, a container type, and process-required container index conditions.

[0320] By controlling a minimum pressure value in the second cleaning chamber in each cycle and a duration of vacuumizing the second cleaning chamber, a removal efficiency of the second cleaning chamber for AMC contaminants in the container is maximized, thereby achieving a better cleaning effect.

[0321] It should be understood that although the steps in the above flowcharts are sequentially displayed according to arrow indications, these steps are not necessarily executed sequentially in the order indicated by the arrows. Moreover, these steps are not necessarily executed sequentially, and the present disclosure does not exclude situations where at least two steps are completed at the same time or are performed alternately. The execution timing between steps should still be determined according to specific logical relationships.

[0322] In an optional embodiment, a first average volumetric flow rate is in a range of 5-100 LPM.

[0323] In a more preferred embodiment, a first average volumetric flow rate is in a range of 15-25 LPM.

[0324] In an optional embodiment, a second average volumetric flow rate is in a range of 50-2000 LPM.

[0325] In an optional embodiment, the duration T_{S23} is 1-100s. In step S23, an efficiency of nitrogen gas and/or inert gas replacing AMC contaminants in the pores decreases as the nitrogen gas or inert gas is filled. When the second equilibrium state is reached, an AMC residual on the container surface tends to stabilize, and at this time continuing to fill nitrogen gas cannot continue to reduce the AMC residual level on the container surface. By controlling a gas filling time, an AMC removal efficiency can be improved, while saving nitrogen gas or inert gas usage and reducing cleaning costs.

[0326] In an optional embodiment, in step S23, while filling nitrogen gas or inert gas into the second cleaning chamber, the vacuum pump extracts gas from the second cleaning chamber. AMC contaminants replaced by nitrogen gas or inert gas are discharged out of the second cleaning chamber together with the gas, reducing a possibility of AMC contaminants re-attaching to the inner wall of the container.

[0327] In an optional embodiment, in step S22, after the pressure in the second cleaning chamber is below the first preset pressure value, the vacuum pump maintains its working state, so that the pressure value in the second cleaning chamber is maintained at the first preset pressure value for a duration T_{S222}. That is, when the second cleaning chamber reaches the first equilibrium state, the vacuum pump continues to work, maintaining its internal pressure at the first preset pressure value, so that AMC contaminants on the container surface fully volatilize under low pressure conditions.

[0328] In an optional embodiment, the vacuum breaking component is connected to a flow meter, and a flow rate of filled gas is adjusted using the flow meter. A gas filling power of the vacuum breaking component changes in real time according to the flow rate of filled gas adjusted by the flow meter, that is, the vacuum breaking component can fill gas into the second cleaning chamber at various different power levels.

[0329] It can be understood that a vacuum breaking component at different gas filling power levels takes different times to complete gas filling in the second cleaning chamber, that is, a gas volumetric flow rate filled per unit time is different.

[0330] In an optional embodiment, as shown in FIG. 19, the second processing unit 2 further includes a second knob assembly (not shown in the figures) and a positioning component (not shown in the figures), both the second knob assembly and the positioning component are

installed on the chamber cover 22. The first cover body and the cassette body can be locked or unlocked under an action of the second knob assembly, and the first cover body is fixed to the chamber cover 22 using the positioning component, and the first cover body and the cassette body are unlocked.

[0331] Separating the first cover body and the cassette body before drying can improve drying sufficiency of the first cover body and the cassette body, further improving an AMC removal effect.

[0332] In an optional embodiment, as shown in FIG. 23, step S21 further comprises the following steps.

[0333] S211, connecting the first cover body to the chamber cover 22.

[0334] Connecting the first cover body to the chamber cover 22 facilitates positioning operation for the first cover body.

[0335] S212, separating the first cover body from the cassette body.

[0336] After cleaning is completed in the second processing unit 2, the first cover body and the cassette body are locked using the second knob assembly. When the container is moved to the second processing unit 2 for drying operations, the first cover body and the cassette body are separated to improve drying sufficiency of the first cover body and the cassette body, further improving an AMC removal effect.

[0337] S213, inverting the cassette body and placing it in the chamber body 21. This improves convenience of manipulator operations for holding the cassette body. Compared with being placed sideways, manipulator operations are more convenient when the cassette body is inverted.

[0338] In an optional embodiment, as shown in FIG. 19, a positioning block 211 is installed on a bottom wall of the chamber body 21, and the positioning block 211 is configured to carry the cassette body.

[0339] Furthermore, a pad block 211a is connected to the positioning block 211. When the container is directly placed on a surface of the positioning block, friction between the container and the metal positioning block easily generates particulate matter. The pad block 211a is made of polymer material, and when the pad block contacts the container, the pad block 211a made of polymer can prevent the container from directly contacting and rubbing against the positioning block 211 to generate particles when placed.

[0340] Optionally, the pad block 211a is made of Teflon, which can withstand temperatures below 260 °C. The Teflon pad block can still maintain stable physical and chemical properties at high temperatures, not easily decomposing and melting, which would increase sources of contaminants in the second cleaning chamber. Secondly, Teflon has an extremely low friction

coefficient, so even if there is relative movement between the Teflon pad block and the container, particles will not be generated due to friction. Furthermore, Teflon is a non-sticky material, and foreign matter adhering to its surface can be easily treated. In addition, before using the pad block 211a, it undergoes vacuum aging treatment. During vacuum aging treatment of the pad block 211a, volatile contaminants in the pad block 211a volatilize during the vacuum treatment process, which can avoid the pad block 211a volatilizing contaminants during heating or vacuumizing operations.

[0341] In an optional embodiment, as shown in FIG. 20, the positioning block 211 includes a plurality of first support blocks 2111, the plurality of first support blocks 2111 are distributed at edges of the bottom wall of the chamber body 21, and the plurality of first support blocks 2111 are configured to support the cassette body inverted in the second cleaning chamber.

[0342] In the embodiments of the present disclosure, a space is formed between adjacent first support blocks 2111, that is, an inner cavity of the cassette body and an outer side space of the cassette body are communicated.

[0343] In an optional embodiment, as shown in FIG. 19, the chamber body 21 is provided with at least one gas extraction port and at least one gas inlet, the gas extraction port is connected to the vacuum pump, the at least one gas extraction port is located on the bottom wall of the chamber body 21 and the gas extraction port faces an opening of the cassette body. The gas inlet is connected to the vacuum breaking component, the gas inlet is located on the bottom wall of the chamber body 21, and the gas inlet faces the opening of the cassette body.

[0344] In an optional embodiment, as shown in FIG. 19, the chamber body 21 is provided with at least one first gas extraction port, the first gas extraction port is connected to the vacuum pump, the at least one first gas extraction port is arranged on the bottom wall of the chamber body 21, and the first gas extraction port faces the opening of the cassette body.

[0345] As shown in FIG. 19, arrows in FIG. 19 indicate a gas flow direction when the vacuum pump vacuumizes. During the vacuum pump vacuumizing process, the first gas extraction port located on the bottom wall of the chamber body 21 facilitates extraction of gas from the inner cavity and the outer side of the cassette body, improving vacuumizing efficiency. The first gas extraction port arranged at a position facing the opening of the cassette body can quickly extract gas inside the container, more rapidly reducing an internal pressure of the container, and increasing a pressure difference on the AMC contaminant surface, which is conducive to removal of AMC contaminants. In addition, the first gas extraction port being close to the opening of the cassette body can avoid gas from the outer side of the cassette body entering the

inner cavity of the cassette body, further avoiding secondary contamination of the inner cavity of the cassette body by gas from the outer side of the cassette body.

[0346] In an optional embodiment, as shown in FIG. 21, the chamber body 21 is provided with two gas extraction ports, one of which is a first gas extraction port arranged at the opening of the cassette body, the first gas extraction port is connected to the vacuum pump, and under an action of the vacuum pump, gas from the inner cavity of the cassette body is directly extracted from the first gas extraction port. The other is a second gas extraction port located at another position of the chamber body 21 to extract gas from the outer side space of the cassette body.

[0347] By simultaneously extracting gas from the second cleaning chamber through the first gas extraction port and the second gas extraction port, an extraction flow rate can be increased, which helps the second cleaning chamber reach a vacuum state faster, reducing process time and improving processing efficiency. Furthermore, since a contamination degree of an outer surface of the container and an inner surface of the container is different, a contamination degree of the inner surface of the container is lower and a requirement for a contaminant residual amount on the surface is relatively higher. During processing of the container, an AMC contaminant concentration in an outer region of the container in the vacuum chamber is greater than a concentration inside the container. Utilizing the first gas extraction port and the second gas extraction port to simultaneously extract gas inside and outside the container can enable contaminants inside and outside the container to be simultaneously carried out of the second cleaning chamber with the extracted gas, avoiding secondary contamination of the inside of the container by AMC contaminants in the outer side space of the container.

[0348] Furthermore, by controlling extraction flow rates of the first gas extraction port and the second gas extraction port, so that a pressure in the inner space of the container is slightly greater than a pressure in the outer space of the container, secondary contamination of the inside of the container by AMC contaminants in the outer side space of the container can be better avoided.

[0349] Furthermore, by arranging one gas extraction port at a position other than facing the opening of the container, compared with a scheme having only one gas extraction port at a position facing the opening of the container, AMC released from other positions on the outer surface of the container, such as a top of the container, due to low vacuum, does not need to travel a longer distance, such as passing through a position near the opening of the container to be extracted and discharged by the gas extraction port facing the opening of the container, but can be directly discharged through the gas extraction port arranged at a position other than facing the opening of the container. Therefore, a probability of AMC settling near the wall of the opening of the container is reduced.

[0350] In an optional embodiment, as shown in FIG. 19, the chamber body 21 is provided with at least one first gas inlet, wherein at least one first gas inlet is located at the opening of the container, the first gas inlet is connected to the vacuum breaking component, and under an action of the vacuum breaking component, nitrogen gas and/or inert gas is directly filled into the inner cavity of the cassette body, so that during replacement with a small flow rate of nitrogen gas and/or inert gas or during vacuum breaking by large flow rate, the filled nitrogen gas and/or inert gas will preferentially enter the inner surface of the container and replace AMC and water vapor on the inner surface, thereby improving an efficiency of removing AMC and water vapor from the inside of the container.

[0351] In an optional embodiment, as shown in FIG. 21, the chamber body 21 is provided with two gas inlets, one of which is a first gas inlet arranged at the opening of the cassette body, and the other is a second gas inlet located at another position of the chamber body 21 to fill gas into the outer side space of the cassette body. The first gas inlet and the second gas inlet are connected to the vacuum breaking component, and under an action of the vacuum breaking component, nitrogen gas and/or inert gas is directly filled into the inner cavity of the cassette body, greatly improving a gas filling effect, such that a vacuum breaking can be achieved faster. A larger pressure difference is instantly formed on the surface of the container, so that AMC and water vapor in the surface pores of the container undergo more effective replacement with nitrogen gas and/or inert gas, further improving an AMC and water vapor removal effect. The other gas inlet is located at another position of the chamber body 21 to fill nitrogen gas and/or inert gas into the outer side space of the cassette body.

[0352] In an alternative embodiment, as shown in FIG. 22, the positioning block 211 includes a second support block 2112, the second support block 2112 surrounds a periphery of the bottom wall of the chamber body 21, and the second support block 2112 is configured to support the cassette body inverted in the second cleaning chamber.

[0353] In the embodiments of the present disclosure, when the cassette body is inverted and placed on the second support block 2112, the chamber bottom wall, the second support block 2112 and the inner cavity of the cassette body form an independent space, that is, two independent spaces are formed in the second cleaning chamber, namely the inner cavity of the cassette body and the outer side space of the cassette body.

[0354] Based on the fact that AMC present on the outer wall of the container is far greater than AMC present on the inner wall of the container during use, the embodiments of the present disclosure place the inner cavity of the cassette body and the outer wall of the container in two independent spaces. On one hand, this can avoid secondary contamination of the inner cavity of

the cassette body by AMC removed from the outer wall of the container. On the other hand, different drying parameters can be utilized to improve an AMC removal efficiency.

[0355] It should be noted that the two independent spaces formed by the cassette body inverted on the second support block 2112 are not sealed spaces, and in fact there will still be a small amount of gas flow between the two spaces.

[0356] In the embodiments of the present disclosure, the chamber body 21 is provided with at least two gas inlets and gas extraction ports, which can be referred to FIG. 21, and will not be described in detail here.

[0357] In an optional embodiment, step S213 further comprises:

[0358] inverting the cassette body in the second cleaning chamber to form an inner cavity space and an outer side space of the cassette body.

[0359] In step S22 and step S24, the cleaning method further comprises:

[0360] separately vacuumizing the inner cavity space and the outer side space of the cassette body.

[0361] By separately vacuumizing the inner cavity and the outer side space of the cassette body, an internal pressure of the cassette body can be reduced faster, thereby removing AMC and moisture from the inside of the cassette body faster. A cleanliness level of the exterior of the container is lower than that of the interior of the container, and even after cleaning, a cleanliness level of the exterior of the container is lower than that of the interior, especially in terms of AMC contaminant index. By separately vacuumizing the inner cavity space of the cassette body, not only can an extraction efficiency be improved, but also secondary contamination of the inner cavity of the cassette body by AMC in the outer side space of the cassette body can be avoided.

[0362] Furthermore, an extraction flow rate for vacuumizing the inner cavity space of the cassette body is less than an extraction flow rate for vacuumizing the outer cavity space of the cassette body, so that a pressure in the inner cavity space of the cassette body is slightly greater than a pressure in the outer cavity space of the cassette body. By controlling a gas flow direction in the second cleaning chamber, gas from the outer side space of the cassette body entering the inner space of the cassette body is avoided, further reducing a possibility of secondary contamination.

[0363] In an optional embodiment, as shown in FIG. 24, the second processing unit 2 further includes a heating component, the heating component includes a plurality of heaters, and the plurality of heaters are installed on an inner wall of the chamber body 21 to heat the chamber body 21 and gas in the second cleaning chamber.

[0364] In an optional embodiment, the heating component includes a first heater 231 and a second heater 232, the first heater 231 and the second heater 232 are respectively installed on a top and a bottom wall of the chamber body 21. The opening of the cassette body is arranged opposite to the second heater 232, that is, when the cassette body is inverted on the positioning block 211 of the chamber body 21, the second heater 232 is located below the opening of the cassette body and can be configured to heat an inner space of the cassette body.

[0365] It can be understood that the first heater 231 is configured to heat gas on the outer side of the cassette body, and the second heater 232 is configured to heat an inner space of the container.

[0366] Both the first heater 231 and the second heater 232 are ceramic heating plates, and radiation heating is performed using the ceramic heating plates. Compared with contact heating methods, radiation heating does not require a heating medium, and can directly transfer heat to the container surface, thereby uniformly heating the container surface and moisture and other impurities thereon, shortening heating time. Meanwhile, by adopting a non-contact heating method, the ceramic heating plates do not contact the container, avoiding secondary contamination of the container when the heating device heats the container. In addition, the first heater 231 and the second heater 232 can also be other types of heaters, which are not limited in the embodiments of the present disclosure.

[0367] In an optional embodiment, the second processing unit 2 further includes a first temperature sensor and a second temperature sensor, and the first temperature sensor and the second temperature sensor are respectively configured to detect a temperature on the outer side of the cassette body and a temperature inside the container. When detected values of the first temperature sensor and the second temperature sensor reach set values, the first heater 231 and the second heater 232 stop heating, ensuring that a temperature in the second cleaning chamber is within a set threshold range. In an optional embodiment, the heating component further includes a third heater, the third heater is connected to the vacuum breaking component, and the third heater is configured to heat gas before filling it into the second cleaning chamber.

[0368] In an optional embodiment, before step S21, the second cleaning chamber is heated by the heating component, so that an ambient temperature in the second cleaning chamber is in a first temperature range.

[0369] The first temperature range is 40-80 °C, and pre-heating the second cleaning chamber before processing the container can reduce a time for subsequently heating the second cleaning chamber in subsequent processing steps, improving processing efficiency of the second cleaning chamber.

[0370] In an optional embodiment, in step S21, after the container is placed in the second cleaning chamber, the second cleaning chamber is heated, so that an ambient temperature in the second cleaning chamber is greater than or equal to 50 °C and less than or equal to 100 °C.

[0371] When the second cleaning chamber is in a relatively high temperature environment, Brownian motion of gas in the second cleaning chamber is active. It can be understood that AMC on the container surface and in the surface pores of the container can move to a suspended state. On one hand, AMC in a suspended state is discharged out of the second cleaning chamber after a vacuumizing operation. On the other hand, active AMC in a suspended state can greatly reduce a situation where AMC re-adheres to the container surface or the surface pores of the container.

[0372] In an optional embodiment, in step S21, the inner cavity of the cassette body is heated, and a cassette body inner cavity having a relatively high temperature is conducive to volatilization and discharge of AMC and moisture in the container. In addition, during the vacuumizing process, as the pressure decreases, a temperature in the second cleaning chamber will also decrease. By heating the inner cavity of the cassette body, suspended AMC can be prevented from adsorbing onto the container surface or the surface pores of the container due to temperature decrease.

[0373] In an optional embodiment, in step S21, the inner cavity space and the outer side space of the cassette body are respectively heated, and a temperature difference between gas in the inner cavity space of the cassette body and gas in the outer side space of the cassette body is less than or equal to 10 °C, preferably within 5 °C.

[0374] Controlling a temperature difference between the inside and outside of the container within 10 °C can prevent deformation due to excessive temperature difference between inner and outer walls, or prevent large deformation amount due to excessive temperature difference between inner and outer walls.

[0375] In an optional embodiment, in step S23 and step S24, the cleaning method further comprises:

[0376] filling heated nitrogen gas and/or inert gas into the second cleaning chamber.

[0377] Generally, nitrogen gas and/or inert gas is stored at a low temperature. When low temperature nitrogen gas and/or inert gas is directly filled into the second cleaning chamber, surface pores of the container based on thermal expansion and contraction easily adhere AMC nearby, and in a low temperature environment, Brownian motion of gas in the second cleaning chamber is slow, which is not conducive to AMC removal.

[0378] Filling heated nitrogen gas and/or inert gas into the chamber can keep the second cleaning chamber continuously in a high temperature environment, improve volatility of AMC, avoid a thermal expansion and contraction phenomenon, and improve AMC removal efficiency.

[0379] In an optional embodiment, in step S22 and step S24, the cleaning method further comprises:

[0380] discharging gas from the second cleaning chamber through a first gas extraction port provided on a side wall of the chamber body 21, wherein the first gas extraction port is close to the opening of the cassette body.

[0381] During the vacuum pump vacuumizing process, the first gas extraction port located on the side wall of the chamber body 21 facilitates extraction of gas from the inner cavity and the outer side of the cassette body, improving vacuumizing efficiency. In addition, the first gas extraction port being close to the opening of the cassette body can avoid gas from the outer side of the cassette body entering the inner cavity of the cassette body, further avoiding secondary contamination of the inner cavity of the cassette body by gas from the outer side of the cassette body.

[0382] The container referred to in the present disclosure can be a front opening unified pod. In the prior art, front opening unified pods are made of various different materials, and different materials have different degrees of internal pores. An efficiency of removing AMC contaminants from different pores is different. Therefore, if a fixed processing time is set, for particularly difficult-to-clean materials, an AMC residual on the processed container surface may still not meet requirements, while for relatively easy-to-clean materials, the container is over-cleaned, reducing cleaning efficiency while wasting resources and increasing processing costs.

[0383] For the above technical problem, an optional embodiment of the present disclosure provides an AMC online detector. As shown in FIG. 25, the AMC online detector is connected to the chamber body 21 and is configured to monitor an AMC content in the second cleaning chamber in real time. The AMC online detector extracts gas from the second cleaning chamber and detects the extracted gas to obtain an AMC content value in the second cleaning chamber. According to data fed back by the detection device, it is determined whether the container is qualified. Thus, a processing time can be adjusted in real time according to different states of the container, ensuring a processing effect while reducing processing time, and avoiding a situation where the container continues to be processed after being qualified.

[0384] In an optional embodiment, as shown in FIG. 26, the cleaning method provided by the embodiments of the present disclosure further comprises:

[0385] performing real-time online detection on gas in the second cleaning chamber to obtain an AMC content in the gas.

[0386] In an optional embodiment, in step S22, gas from the second cleaning chamber is extracted in real time and an AMC content of the extracted gas is detected. It is determined whether the AMC content meets a set threshold, and it is further determined whether the second chamber is in a first equilibrium state, a second equilibrium state, or a third equilibrium state.

[0387] When AMC content detection results are not within the set threshold range, steps S23, S24 and S25 are cycled, that is, vacuumizing is repeatedly performed, then replacement with a small flow rate of nitrogen gas and/or inert gas is performed, and then vacuum breaking with a large flow rate of nitrogen gas and/or inert gas is performed.

[0388] In the embodiments of the present disclosure, the AMC online detector can obtain an AMC content of gas in the second cleaning chamber in real time. When the AMC content meets a standard, drying can be stopped in a timely manner, and when the AMC content does not meet a standard, cyclic drying operations continue, which can not only improve an AMC removal efficiency but also improve an AMC removal effect.

[0389] In an optional embodiment, gas from the second cleaning chamber is extracted and detected to identify specific components in the AMC. It can be understood that after identifying specific AMC components, targeted cleaning can be performed on the container to improve a cleaning effect.

[0390] As shown in FIG. 27, FIG. 27 is a coordinate graph of pressure and time in the second cleaning chamber. Time t1 is a stage of vacuumizing the second cleaning chamber, and as time increases, the pressure in the second cleaning chamber decreases. Between t1 and t2, filling is performed using a small flow rate of nitrogen gas and/or inert gas, while maintaining gas extraction from the second cleaning chamber. In the time period from t2 to t3, filling is performed using a large flow rate of nitrogen gas and/or inert gas, and the pressure in the second cleaning chamber gradually increases during this stage, and can increase to an atmospheric pressure state. After t3, a cyclic operation can be performed.

[0391] Within time t1, that is, the vacuumizing stage, as the pressure in the second cleaning chamber decreases, AMC contaminants attached to the container surface gradually volatilize and are discharged along with the extracted gas, and an AMC contaminant residual level on the container surface overall shows a downward trend. In the time period from t1 to t2, as a small flow rate of nitrogen gas or inert gas is filled, a method of replacing AMC contaminants in the container pores with nitrogen gas or inert gas is used to remove AMC contaminants that are

difficult to remove during the vacuumizing process, so that an AMC contaminant residual in the container is further reduced.

[0392] In the process of cycling vacuumizing, replacement with a small flow rate of nitrogen gas and/or inert gas, and then vacuum breaking with a large flow rate of nitrogen gas and/or inert gas, residual AMC contaminants in the container gradually decrease. As the number of cycles increases, a removal effect of residual AMC contaminants in the container in each cycle gradually decreases.

[0393] To ensure an AMC contaminant removal effect while ensuring cleaning efficiency, the AMC online detector is used to perform AMC content detection. In each cycle, through the AMC online detector, an AMC content of gas extracted from the second cleaning chamber can be obtained in real time. When the AMC content is not within a set qualified range, a next cycle is performed; otherwise, the cleaning step is completed.

[0394] In an optional embodiment, during the vacuumizing process, gas from the second cleaning chamber is extracted in real time and an AMC content of the extracted gas is detected, and it is determined whether the container has reached a cleaning standard through an AMC content value and a change in the AMC content value.

[0395] In the embodiments of the present disclosure, by jointly determining a cleaning standard for the container through an AMC content value and a change in the AMC content value, a cleaning effect on the container can be further improved.

[0396] The embodiments of the present disclosure further provide a cleaning system for a semiconductor storage container, comprising the second processing unit 2 provided in the above embodiments.

[0397] In the fourth aspect, the embodiments of the present disclosure provide a cleaning method, a cleaning unit and a cleaning system for cleaning AMC contaminants from a semiconductor storage container based on detection results. As shown in FIG. 28, the cleaning method comprises the following steps.

[0398] S41, placing a preliminarily cleaned container in a second cleaning chamber.

[0399] The preliminary cleaning refers to cleaning the container in the first cleaning chamber in the above embodiments, but of course is not limited thereto.

[0400] S42, vacuumizing the second cleaning chamber for a duration T_{S42}.

[0401] S43, filling the second cleaning chamber with gas to restore atmospheric pressure in the second cleaning chamber, wherein the gas comprises nitrogen gas and/or inert gas.

[0402] S44, detecting a contaminant level in the second cleaning chamber to obtain detection results, wherein the detection results are an AMC contaminant level.

[0403] S45, performing subsequent processing according to the detection results.

[0404] In an optional embodiment, detected contaminant types for gas in the second detection unit include humidity, acidic contaminants (acids, abbreviated as MA), alkaline contaminants (bases, abbreviated as MB), and condensable contaminants (condensables, abbreviated as MC).

[0405] In the embodiments of the present disclosure, the second cleaning chamber is connected to a second detection unit, the second detection unit is configured to perform online detection and real-time analysis of a contaminant level in the second cleaning chamber to obtain detection results. A subsequent processing mode for the container is determined according to the detection results.

[0406] Since each container has a different contaminant residual level before processing, and after undergoing a fixed processing flow, its contaminant level is also different, and for different materials, an efficiency of each processing step in removing contaminants is also different. According to different contaminant residual levels after processing of each container, subsequent processing parameters for the container are determined, processing resources are reasonably allocated, a pass rate of container cleaning is ensured, and processing efficiency of containers can be improved.

[0407] In an optional embodiment, in step S44, the AMC includes one or more of SO_2, inorganic ammonia, VOC, organic ammonia, and acids.

[0408] In an optional embodiment, step S44 comprises detecting gas discharged from the second cleaning chamber in step S42 through a detection device to obtain the detection results.

[0409] In an optional embodiment, step S44 comprises detecting gas discharged from the second cleaning chamber in step S43 through a detection device to obtain the detection results.

[0410] In an optional embodiment, step S45 comprises:

[0411] determining whether the detection results are below a third preset threshold.

[0412] If yes, the container is transferred to the unloading unit.

[0413] If no, steps S42 to S45 are cycled.

[0414] In the embodiments of the present disclosure, by detecting a contaminant level in gas discharged from the second cleaning chamber during the processing process, a contaminant residual condition inside the container is obtained based on the detection results. This enables determining whether the container is qualified for cleaning in the second cleaning chamber, ensuring that the container after processing in the second cleaning chamber meets an unloading requirement, avoiding unqualified cleaned containers from flowing into the unloading unit, while also avoiding a problem of rework after detection.

[0415] In an optional embodiment, transferring the container to the unloading unit comprises:

[0416] before unloading, filling a certain amount of gas into the container and then detecting an AMC residual level in the discharged gas, and determining whether it is qualified.

[0417] In an optional embodiment, step S45 further comprises:

[0418] determining whether the detection results are higher than a fourth preset threshold, wherein the fourth preset threshold is higher than the third preset threshold.

[0419] If yes, an alarm signal is issued or the container is transferred to the first cleaning chamber for cleaning.

[0420] Both the third preset threshold and the fourth preset threshold can be set comprehensively according to a cleaning processing capability of the second cleaning chamber, a container type, and process-required container index conditions.

[0421] In an optional embodiment, multiple sub-thresholds can also be set between the third preset threshold and the fourth preset threshold, so that corresponding preset cleaning procedures can be selected according to different sub-thresholds.

[0422] The third preset threshold is that when a contaminant level in the second cleaning chamber meets this threshold, a container cleaned in the second cleaning chamber can meet contaminant control requirements for final unloading of the container.

[0423] The fourth preset threshold is that when a contaminant level in the second cleaning chamber is higher than this threshold, a cleaning capability of the second cleaning chamber cannot be guaranteed, and after internal cleaning in the second cleaning chamber, a contaminant residual level inside the container cannot meet control requirements.

[0424] The fourth preset threshold is related to parameters for containers that can be qualified to flow into the second cleaning chamber after processing in the first cleaning chamber in the second aspect.

[0425] The fourth preset threshold corresponds to the first preset threshold, and a contaminant residual level in the container controlled by the fourth preset threshold is equivalent to a contaminant residual level in the container controlled by the first preset threshold.

[0426] In an optional embodiment, the third preset threshold is a total AMC content of 60 ppbv; and the fourth preset threshold is a total AMC content of 300 ppbv.

[0427] In an optional embodiment, the third preset threshold is an inorganic ammonia content of 6500 pptv, a VOC content of 55 ppbv, an HF content of 1500 pptv, an SO_2 content of 100 pptv, an ACIDS content of 1000 pptv, and an AMINES content of 1200 pptv; the fourth preset threshold is an inorganic ammonia content of 30 ppbv, a VOC content of 250 ppbv, an HF content of 7000 pptv, an SO_2 content of 450 pptv, an ACIDS content of 4500 pptv, and an AMINES content of 5500 pptv.

[0428] In an optional embodiment, in step S43, the second cleaning chamber is vacuumized for a period of time. In this step, the vacuum pump is in a working state, so that contaminants volatilized from the container are discharged out of the second cleaning chamber together with the discharged gas, reducing a possibility of secondary attachment of contaminants.

[0429] In an optional embodiment, step S43 further comprises:

[0430] S431, filling the second cleaning chamber with gas at a first average volumetric flow rate for a duration T_{S431}, and maintaining a maximum pressure value in the second cleaning chamber to be less than or equal to a second preset pressure value, wherein the gas comprises nitrogen gas or inert gas; and contaminants attached inside the pores are removed through replacement.

[0431] S432, filling the second cleaning chamber with gas at a second average volumetric flow rate for a duration T_{S432}, wherein the gas comprises nitrogen gas or inert gas. In an optional embodiment, step S45 further comprises:

[0432] adjusting process parameters in step S42 according to the detection results, wherein the process parameters include the first preset pressure value and the duration T_{S42}.

[0433] In an optional embodiment, step S45 further comprises:

[0434] adjusting process parameters in step S43 according to the detection results, wherein the process parameters include a flow rate value of the first average volumetric flow rate, the duration T_{S431}, a flow rate value of the second average volumetric flow rate, and the duration T_{S432}.

[0435] The inventor has found through long-term research that there are plastic parts in the second cleaning chamber. Under a negative pressure state, the plastic parts will volatilize AMC, and during the process of cleaning the container, AMC volatilized from the container can adhere to the inner wall of the second cleaning chamber. Meanwhile, during contact between the container and the second cleaning chamber, AMC may also be generated due to friction and other reasons. These contaminant residuals will affect a processing effect of subsequent containers, so the second cleaning chamber needs to be inspected to determine whether an internal environment of the second cleaning chamber meets cleaning requirements.

[0436] In an optional embodiment, the cleaning method further comprises: before the second cleaning chamber cleans the container, detecting a contaminant residual level inside the uncleaned container, and when the detection results are below or equal to a sixth preset threshold, cleaning the container according to the steps in the above embodiments. When the detection results are higher than the sixth preset threshold, the first control unit issues a prompt, indicating

that a contaminant level in the container is relatively high and is not suitable for direct cleaning in the first cleaning chamber.

[0437] In the present embodiment, the sixth preset threshold is a control value for a contaminant residual level of the container in a preceding cleaning process (that is, a control value for the first processing unit referred to in the above embodiments). When the detection results are higher than the sixth preset threshold, it indicates that a contaminant residual level inside the container does not meet a control requirement of the first processing unit, and cleaning of the container by the first processing unit is unqualified. If the container continues to be cleaned in the second cleaning chamber, it may affect a pass rate of cleaning in the second cleaning chamber, so a warning needs to be issued, and a decision on the next processing mode is made by on-site technical personnel after judgment.

[0438] In an optional embodiment, the cleaning method further comprises the step of:

[0439] when no container is placed in the second cleaning chamber, detecting a contaminant level in the second cleaning chamber.

[0440] determining whether the second cleaning chamber meets cleaning requirements. When the detection results are higher than a preset value, the control unit issues an alarm, prompting that the second cleaning chamber needs to be maintained.

[0441] When contaminants in the second cleaning chamber are at a relatively high level, if the container continues to be placed in the second cleaning chamber for cleaning, contaminants in the second cleaning chamber will affect cleaning of the container, which is not conducive to cleaning of the container.

[0442] In an optional embodiment, when the second cleaning chamber is in an empty state, that is, there is no container to be cleaned inside, the second cleaning chamber is cleaned to reduce its internal contaminant residual level.

[0443] In the above embodiments, cleaning of the second cleaning chamber comprises the following steps: keeping the second cleaning chamber in a sealed state, and extracting internal gas thereof through the vacuum pump, wherein internal contaminants of the second cleaning chamber are extracted out of the second cleaning chamber together with the gas. Meanwhile, when the second cleaning chamber is close to a vacuum state, volatilization of contaminants adhering to the surface thereof will also intensify, thereby further reducing a contaminant level inside the second cleaning chamber. Finally, gas is filled to restore atmospheric pressure inside the second cleaning chamber.

[0444] The embodiments of the present disclosure further provide a cleaning unit including any one of the cleaning methods provided in the above embodiments.

[0445] The embodiments of the present disclosure further provide a cleaning system for a semiconductor storage container, comprising the above cleaning unit, wherein the cleaning unit comprises: a second cleaning chamber configured to accommodate the container, a vacuum pump, a vacuum breaking component, a second detection unit and a second control unit, the vacuum pump, the vacuum breaking component and the second detection unit are all connected to the second cleaning chamber, and the vacuum pump, the vacuum breaking component and the second detection unit are all electrically connected to the second control unit. The vacuum pump is configured to vacuumize the second cleaning chamber. The vacuum breaking component is configured to fill gas into the second cleaning chamber, wherein the gas comprises nitrogen gas and/or inert gas. The second detection unit is configured to detect gas in the second cleaning chamber. The second control unit is configured to receive detection results fed back by the second detection unit, and send instructions to the vacuum pump and the vacuum breaking component, so that the vacuum pump and the vacuum breaking component adjust parameters for subsequent processing of the container based on the detection results.

[0446] It should be understood that the above embodiments are all exemplary and are not intended to include all possible implementation manners encompassed by the claims. Without departing from the scope of the present disclosure, various modifications and changes can also be made on the basis of the above embodiments. Similarly, various technical features in the above embodiments can be combined arbitrarily to form additional embodiments of the present disclosure that may not be explicitly described. Therefore, the above embodiments only express several implementation manners of the present disclosure and do not limit the scope of protection of the patent of the present disclosure.

CLAIMS

1. A cleaning method for a semiconductor storage container, characterized by comprising:

S21, placing a cleaned semiconductor storage container in a second cleaning chamber;

S22, vacuumizing the second cleaning chamber for a duration T_{S22}, so that a pressure value in the second cleaning chamber is less than or equal to a first preset pressure value, and maintaining a temperature in the second cleaning chamber between 40-80 °C;

S23, filling the second cleaning chamber with gas at a first average volumetric flow rate for a duration T_{S23}, and maintaining a maximum pressure value in the second cleaning chamber during step S23 to be less than or equal to a second preset pressure value, wherein the gas is clean dry compressed gas; and

S24, filling the second cleaning chamber with gas at a second average volumetric flow rate for a duration T_{S24}, and maintaining a maximum pressure value in the second cleaning chamber during step S24 to be less than or equal to a third preset pressure value, wherein the gas is clean dry compressed gas,

wherein the first average volumetric flow rate is less than the second average volumetric flow rate, and the maximum pressure value in the second cleaning chamber during step the S23 is less than the maximum pressure value in the second cleaning chamber during step the S24.

2. The cleaning method for a semiconductor storage container according to claim 1, wherein after the step S24, the cleaning method further comprises a step of:

S25, cycling the step S22, the step S23 and the step S24 for several times, wherein in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than or equal to a minimum pressure value in the second cleaning chamber in a previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than or equal to a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

3. The cleaning method for a semiconductor storage container according to claim 1, wherein after the step S24, the cleaning method further comprises a step of:

S25, cycling the step S22, the step S23 and the step S24 for several times, wherein in each cycled step S22, a minimum pressure value in the second cleaning chamber is less than a minimum pressure value in the second cleaning chamber in a previous execution of step S22, and/or a duration of vacuumizing the second cleaning chamber is less than a duration of vacuumizing the second cleaning chamber in the previous execution of step S22.

4. The cleaning method for a semiconductor storage container according to claim 1, wherein the step S22 comprises:

maintaining a pressure value of the second cleaning chamber to be less than or equal to the first preset pressure value for a duration T_{S222}.

5. The cleaning method for a semiconductor storage container according to claim 1, wherein in the step S23, maintaining vacuumizing the second cleaning chamber.

6. The cleaning method for a semiconductor storage container according to claim 1, wherein the first preset pressure value is less than or equal to 100 Pa.

7. The cleaning method for a semiconductor storage container according to any one of claims 1 to 6, wherein the cleaning method further comprises:

detecting a contaminant level in the second cleaning chamber to obtain detection results, wherein the contaminant level comprises residual levels of one or more of SO_2, inorganic ammonia, VOC, organic ammonia, and acids; and

performing subsequent processing according to the detection results.

8. A cleaning system, characterized by comprising the cleaning method for a semiconductor storage container according to any one of claims 1 to 7.

9. A cleaning method for a semiconductor storage container, characterized in that the cleaning method is configured to remove residual AMC contaminants inside the semiconductor storage container, wherein the cleaning method comprises following steps:

S12, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber;

S13, blowing a clean dry compressed gas onto a surface of the semiconductor storage container at a fifth average volumetric flow rate for a duration T_{S13};

S14, spraying cleaning liquid onto the surface of the semiconductor storage container to clean the surface of the semiconductor storage container; and

S15, blowing the clean dry compressed gas onto the surface of the semiconductor storage container.

10. The cleaning method for a semiconductor storage container according to claim 9, wherein in step S13 and/or step S15, a temperature of the clean dry compressed gas is greater than or equal to 40 °C and less than or equal to 80 °C.

11. The cleaning method for a semiconductor storage container according to claim 9, wherein step S15 further comprises steps of:

S151, blowing the clean dry compressed gas onto a surface of the semiconductor storage container for a duration T_{S151} to remove residual cleaning liquid in a pipeline; and

S152, blowing the clean dry compressed gas onto the surface of the semiconductor storage container for a duration T_{S152} to remove moisture on the surface of the semiconductor storage container and dry the semiconductor storage container,

wherein a flow rate of the clean dry compressed gas blown onto the surface of the semiconductor storage container in step S151 is greater than a flow rate of the clean dry compressed gas blown onto the surface of the semiconductor storage container in step S152; and the duration T_{S151} is less than the duration T_{S152}.

12. The cleaning method for a semiconductor storage container according to claim 9, wherein during a process of cleaning the semiconductor storage container in the first cleaning chamber, a contaminant residual level of gas discharged from the first cleaning chamber is detected, to determine whether to stop cleaning.

13. The cleaning method for a semiconductor storage container according to claim 9, wherein after step S15, the cleaning method further comprises a step of:

S16, after the semiconductor storage container is removed from the first cleaning chamber, cleaning the first cleaning chamber to reduce an internal contaminant residual level thereof.

14. A cleaning system, characterized by comprising the cleaning method for a semiconductor storage container according to any one of claims 9 to 13.

15. A cleaning method of a semiconductor storage container based on detection results, characterized by comprising following steps:

S31, placing unlocked and separated semiconductor storage container components respectively in a first cleaning chamber;

S32, cleaning the semiconductor storage container in the first cleaning chamber using cleaning liquid;

S33, detecting a contaminant level in the first cleaning chamber to obtain the detection results, wherein types of detected contaminants comprise particles and/or AMC; and

S34, performing subsequent processing according to the detection results,

wherein in step S33, the AMC comprises one or more of SO_2, inorganic ammonia, VOC, organic amines, and acids.

16. The cleaning method of a semiconductor storage container based on detection results according to claim 15, wherein step S34 comprises:

setting a first preset threshold according to process parameters, wherein the first preset threshold is set comprehensively according to a cleaning processing capability of the first cleaning chamber, a container type, and process-required container index conditions; and

determining whether the detection results are below the first preset threshold, wherein when the detection results are below the first preset threshold, the semiconductor storage container completes a cleaning process in the present cleaning chamber;

otherwise, repeating steps S32 and S33.

17. The cleaning method of a semiconductor storage container based on detection results according to claim 16, wherein the step S33 comprises:

setting a second preset threshold according to process parameters, wherein the second preset threshold is greater than the first preset threshold, and the second preset threshold is set comprehensively according to the cleaning processing capability of the first cleaning chamber, the container type, and the process-required container index conditions, wherein

when the detection results are higher than the second preset threshold, a control unit connected to a detection device issues a warning signal.

18. The cleaning method of a semiconductor storage container based on detection results according to claim 15, wherein after step S34, the cleaning method further comprises a step of:

S36, after the semiconductor storage container is removed from the first cleaning chamber, detecting a contaminant level in the first cleaning chamber, and determining whether an environment of the first cleaning chamber meets a requirement for cleaning the semiconductor storage container.

19. The cleaning method of a semiconductor storage container based on detection results according to claim 15, wherein after step S34, the cleaning method further comprises a step of:

S35, after the first cleaning chamber completes cleaning of the semiconductor storage container and the semiconductor storage container is removed from the first cleaning chamber, cleaning the first cleaning chamber.

20. A cleaning system, characterized by comprising the cleaning method of a semiconductor storage container based on detection results according to any one of claims 15 to 19.