# CLEANING METHOD AND DEVICE FOR PACKAGING STRUCTURE

## FIELD OF THE INVENTION

The present invention relates to the field of semiconductor manufacturing equipment, and in particular to a cleaning method and a device for a packaging structure.

## BACKGROUND

A system-on-chip (SoC) integrates a complex, large system into a single large chip. Different from SoCs, heterogeneous chiplets propose to split a large system into several small systems, fabricate each small system into a small chip (chiplet), or even a standard small chip (chiplet), and then reintegrate these small chiplets through packaging technology to achieve or even surpass the performance of the single large chip with a large system.

During chiplet reassembly, a plurality of chiplets are usually integrated onto a large carrier by means of flip-chip bonding. FIGS. 1a and 1b show a packaging structure formed by flip-chip bonding. As shown in FIGS. 1a and 1b, a bump array 13 is formed between a plurality of chiplets 12 and the carrier 11. During flip-chip bonding, flux (e.g., rosin) is used to improve the reliability of bonding between the chiplets 12 and the carrier 11. After the bonding is completed, the bonded packaging structure 10 needs to be cleaned to remove residual flux, so as to avoid adverse effects of residual flux on subsequent packaging processes and thus on product yield.

With the further improvement of packaging density and integration, the size of bumps in the packaging structure continues to shrink, and the gaps between the chiplets and the carrier as well as between the bumps become smaller, making it more difficult for cleaning liquid to enter the tiny gaps between the chiplets and the carrier. This will result in incomplete removal of contaminants such as residual flux in the packaging structure.

Therefore, it is necessary to improve the cleaning method and device for the packaging structure to clean contaminants in the packaging structure.

SUMMARY

In view of the above-mentioned shortcomings of the prior art, the purpose of the present invention is to provide a cleaning method and a device for flip chips, with an aim to solve the problem of incomplete cleaning of contaminants such as residual flux in flip chips in the prior art.

To achieve the above object and other related objects, the present invention provides a cleaning method for a packaging structure, comprising a negative-pressure cleaning process. The negative-pressure cleaning process includes:

adjusting the pressure in a chamber where the packaging structure is located to a preset vacuum pressure;

rotating the packaging structure;

spraying a cleaning fluid at a preset temperature onto the rotating packaging structure to perform the negative-pressure cleaning on the packaging structure;

wherein, the preset vacuum pressure is higher than the vaporization pressure of the cleaning fluid at the preset temperature.

Optionally, during the negative-pressure cleaning, the packaging structure is rotated alternately at a first rotation speed and a second rotation speed, wherein the first rotation speed is higher than the second rotation speed.

Optionally, between the negative-pressure cleaning process and a drying process, there is an atmospheric-pressure cleaning process. The atmospheric-pressure cleaning process includes: adjusting the pressure in a chamber where the packaging structure is located to atmospheric pressure; rotating the packaging structure; spraying deionized water onto the rotating packaging structure to perform atmospheric-pressure cleaning on the packaging structure.

Optionally, when the negative-pressure cleaning process and the atmospheric-pressure cleaning process are performed on the packaging structure in different chambers, a pre-drying process performed in the same chamber as the negative-

pressure cleaning process is further included between the negative-pressure cleaning process and the atmospheric-pressure cleaning process. The pre-drying process includes: stopping spraying the cleaning fluid onto the packaging structure, and rotating the packaging structure; wherein, after the pre-drying is completed for the packaging structure, the surface of the packaging structure is covered with a liquid film.

The present invention also provides a cleaning device for a packaging structure, comprising a control device and at least one first cleaning module, the first cleaning module comprising:

a first chamber;

a first chuck, placed in the first chamber, for holding the packaging structure to be cleaned;

a first rotating device, for driving the first chuck to rotate;

a first fluid supply device, for spraying at least one of the cleaning fluid or dry gas onto the surface of the packaging structure;

a first pressure adjusting device, for adjusting the pressure in the first chamber;

a first temperature adjusting device, for adjusting the temperature of the cleaning fluid supplied to the first fluid supply device;

wherein, the control device is configured to control the first cleaning module to execute the above-mentioned cleaning method for the packaging structure.

As described above, the cleaning method and device for the packaging structure provided by the present invention have the following beneficial effects:

1. The packaging structure is cleaned by spraying the cleaning fluid at the preset temperature onto the rotating packaging structure under negative pressure. The principle that the surface tension of the cleaning fluid decreases under negative pressure is utilized to promote the flow of the cleaning fluid in the tiny gaps of the packaging structure, so as to clean contaminants in the packaging structure;

2. The cleaning fluid is prevented from being vaporized before reaching the cleaning area of the packaging structure by setting the preset vacuum pressure during the negative-pressure cleaning of the packaging structure to be higher than the vaporization pressure of the cleaning fluid at the preset temperature, which is conducive to achieving a better cleaning effect;

3. During the negative-pressure cleaning, while the cleaning fluid is sprayed onto the packaging structure, the packaging structure is rotated alternately at high and low rotation speeds, which makes it easier to fling off the cleaning fluid and contaminants, prevent residual cleaning fluid, and improve the cleaning effect;

4. After the negative-pressure cleaning, atmospheric-pressure cleaning is performed on the packaging structure, which can further remove residual cleaning chemicals on the packaging structure;

5. When the negative-pressure cleaning and atmospheric-pressure cleaning are performed on the packaging structure in different chambers, after the negative-pressure cleaning is completed, a pre-drying process is performed on the packaging structure, so that the surface of the packaging structure remains wet during the transfer of the packaging structure to the chamber for atmospheric-pressure cleaning, so as to avoid oxidation on the surface of the packaging structure.

## BRIEF DESCRIPTION OF THE DRAWINGS

The features and performances of the present invention are further described by the following embodiments and the accompanying drawings.

FIG. 1a shows a top schematic view of a known packaging structure;

FIG. 1b shows a cross-section schematic view of a known packaging structure;

FIG. 2 shows a layout view of a cleaning device for the packaging structure according to Embodiment 1 of the present invention;

FIG. 3 shows a schematic view of a first cleaning module according to Embodiment 1 of the present invention;

FIG. 4 shows a schematic view of a second cleaning module according to Embodiment 1 of the present invention;

FIG. 5 shows a flowchart of a cleaning method for the packaging structure according to Embodiment 1 of the present invention;

FIG. 6 shows a graph describing the relationship between the vaporization pressure and temperature of deionized water;

FIG. 7 shows a layout view of a cleaning device for the packaging structure according to Embodiment 2 of the present invention;

FIG. 8 shows a layout view of a cleaning device for the packaging structure according to Embodiment 3 of the present invention; and

FIG. 9 shows a flowchart of a cleaning method for the packaging structure according to Embodiment 3 of the present invention.

## PREFERRED EMBODIMENTS OF THE INVENTION

The following describes the embodiments of the present invention through specific examples. Those skilled in the art can easily understand other advantages and effects of the present invention from the content disclosed in this specification. The present invention can also be implemented or applied through other different specific embodiments, and various details in this specification can also be modified or altered in various ways based on different viewpoints and applications without departing from the spirit of the present invention.

Please refer to FIGS. 1 to 9. It should be noted that the diagrams provided in these embodiments only schematically illustrate the basic concept of the present invention. The diagrams only show the components related to the present invention rather than being drawn according to the number, shape, and size of components in actual implementation. The form, quantity, and proportion of each component in actual implementation can be altered arbitrarily, and the component layout form may also be more complex.

Embodiment 1

FIGS. 1a and 1b show a known packaging structure 10. The packaging structure 10 comprises a carrier 11 and at least one chiplet 12. The chiplets 12 are flip-chip bonded to the carrier 11 through the bump array 13. As mentioned above, when the chiplets 12 are flip-chip bonded to the carrier 11, some contaminants such as flux will remain between the chiplets 12 and the carrier 11. To avoid the impact of these contaminants on subsequent packaging processes, the residual contaminants need to be cleaned.

FIG. 2 shows an exemplary cleaning device 100 according to an embodiment disclosed in the present application. The cleaning device 100 can be used to implement the cleaning method herein to clean residual contaminants in the packaging structure 10.

As shown in FIG. 2, the cleaning device 100 comprises a control device 110, a front-end module 120, a transfer module 130, at least one first cleaning module 140, and at least one second cleaning module 150. The number of the first cleaning modules 140 is greater than the number of the second cleaning modules 150. Specifically, the ratio of the number of the first cleaning modules 140 to the second cleaning module 150 ranges from 3:1 to 8:1 (e.g., 5:1). In this embodiment, the first cleaning modules 140 and the second cleaning module 150 are arranged at the backside of the front-end module 120 and on both sides of the transfer module 130, wherein the second cleaning module 150 is arranged at a position far from the front-end module 120. The front-end module 120 is configured with at least one loading port 121 for loading the packaging structure 10. The loading ports 121 are used to load the packaging structure 10 to be cleaned and unload the cleaned packaging structure 10. The transfer module 130 is configured with a manipulator 131, and the manipulator 131 is used to transfer the packaging structure 10. In Embodiment 1, the first cleaning modules 140 are used to perform the negative-pressure cleaning process S1 and the pre-drying process S2 on the packaging structure 10. The second cleaning module 150 is used to perform the atmospheric-pressure cleaning process S3 and the drying process S4 on the packaging structure 10. Wherein, the specific content on the negative-pressure cleaning process, pre-drying process, atmospheric-pressure cleaning process, and drying process will be described in detail later.

The control device 110 can be a computing device (e.g., computer) providing a processor for executing instructions and a memory for storing instructions, etc., for controlling the actions of various components in the first cleaning modules 140 and the second cleaning module 150, so that the first cleaning modules 140 and the second cleaning module 150 execute the corresponding processes in the cleaning method of the present application, and for controlling the transfer module 130 to transfer the packaging structure 10 among the front-end module 120, the first cleaning modules 140, and the second cleaning module 150. For example, the control device 110 controls the manipulator 131 to transfer the packaging structure 10 along the following path: loading ports 121 → the first cleaning modules 140 → the second cleaning module 150 → loading ports 121.

As shown in FIG. 3, the first cleaning module 140 comprises components such as a first chamber 141, a first chuck 142, a first rotating device 143, a first fluid supply device 144, a first pressure adjusting device 145, a first temperature adjusting device 146, and a first spraying pressure adjusting device 147. The first chamber 141 can provide a closed space for accommodating the packaging structure 10. The first chuck 142 is placed in the first chamber 141 for holding the packaging structure 10. The first rotating device 143 is used to drive the first chuck 142 to rotate, so that the packaging structure 10 can rotate accordingly. The control device 110 can control the rotation speed of the first chuck 142 through the first rotating device 143, for example, control the rotation speed of the first chuck 142 to vary within the range from 0 to 3000 r/min.

The first fluid supply device 144 is used to spray the cleaning fluid onto the surface of the packaging structure 10. In an embodiment, the first fluid supply device 144 comprises a supply source 1441, a supply pipeline 1442, and a nozzle 1443. The supply source 1441 is used to store the cleaning fluid. The nozzle 1443 is placed in the first chamber 141 and connected to the supply source 1441 through the supply pipeline 1442, for spraying the cleaning fluid onto the packaging structure 10. In an embodiment, the cleaning fluid includes at least one of deionized water and saponifier-containing liquid. Wherein, the saponifier-containing liquid is, for example, an aqueous solution of saponifier with a mass fraction of 5% to 10%, and the major constituents of the saponifier include, for example, 2-amino-2-methyl-1-propanol.

The first pressure adjusting device 145 is used to adjust the pressure in the first

chamber 141. In this embodiment, the control device 110 controls the first pressure adjusting device 145 to adjust and maintain the pressure in the first chamber 141 at the preset vacuum pressure, so as to perform the negative-pressure cleaning process on the packaging structure 10. During the negative-pressure cleaning, the preset vacuum pressure in the first chamber 141 is set to a value between 25 Torr and 150 Torr.

In an embodiment, the first pressure adjusting device 145 is configured with a pressure reduction pipeline L1. The pressure reduction pipeline L1 is connected to the first chamber 141, and a vacuum pump 1451 is configured on the pressure reduction pipeline L1. The control device 110 can control the vacuum pump 1451 to vacuumize the first chamber 141, so that the pressure in the first chamber 141 is adjusted to the preset vacuum pressure. In addition, the first pressure adjusting device 145 is also configured with a vacuum breaking pipeline L2. The vacuum breaking pipeline L2 is connected to the first chamber 141, and a vacuum breaking valve 1452 is configured on the vacuum breaking pipeline L2. After the negative-pressure cleaning process in the first chamber 141 is completed, the control device 110 can open the vacuum breaking valve 1452 to allow air to enter the first chamber 141, break the vacuum degree in the first chamber 141, and restore the first chamber 141 to atmospheric pressure, so as to facilitate operations such as taking out the packaging structure 10 from the first chamber 141 via the transfer module 130.

The first temperature adjusting device 146 adjusts the temperature of the cleaning fluid sprayed onto the packaging structure 10. In this embodiment, the control device 110 controls the first temperature adjusting device 146 to heat the cleaning fluid before the cleaning fluid is supplied to the nozzle 1443, so that the nozzle 1443 sprays the cleaning fluid at the preset temperature onto the packaging structure 10. During the negative-pressure cleaning, the preset temperature of the cleaning fluid is set to a value between 40°C and 60°C. In an embodiment, the first temperature adjusting device 146 comprises temperature control components such as a heater 1461 and a temperature sensor 1462 arranged on the supply pipeline 1442. For example, the control device 110 controls the heating power of the heater 1461 according to the temperature of the cleaning fluid in the supply pipeline 1442 detected by the temperature sensor 1462, so that the temperature of the cleaning fluid reaches the preset temperature. In some embodiments, the first temperature adjusting device 146 can also be arranged on the

supply source 1441.

The first spraying pressure adjusting device 147 adjusts the spraying pressure of the cleaning fluid sprayed onto the packaging structure 10. In this embodiment, the control device 110 controls the first spraying pressure adjusting device 147 to pressurize the cleaning fluid before the cleaning fluid is supplied to the nozzle 1443, so that the nozzle 1443 sprays the cleaning fluid at a preset spraying pressure onto the packaging structure 10. During the negative-pressure cleaning, the preset spraying pressure of the cleaning fluid is set to a value between 10 psi and 70 psi. In an embodiment, the first spraying pressure adjusting device 147 comprises hydraulic adjusting components such as a booster pump 1471, a pressure regulating valve 1472, and a pressure sensor 1473 arranged on the supply pipeline 1442. For example, the control device 110 controls the booster pump 1471 to pressurize the cleaning fluid in the supply pipeline 1442, and controls the opening of the pressure regulating valve 1472 according to the pressure of the cleaning fluid in the supply pipeline 1442 detected by the pressure sensor 1473, so that the spraying pressure of the cleaning fluid reaches the preset spraying pressure.

As shown in FIG. 4, the second cleaning module 150 comprises components such as a second chamber 151, a second chuck 152, a second rotating device 153, a second fluid supply device 154, and a second pressure adjusting device 155. The second chuck 152 is placed in the second chamber 151 for holding the packaging structure 10. The second rotating device 153 is used to drive the second chuck 152 to rotate, so that the packaging structure 10 can rotate accordingly. The control device 110 can control the rotation speed of the second chuck 152 through the second rotating device 153, for example, control the rotation speed of the second chuck 152 to vary within the range from 0 to 3000 r/min.

The second fluid supply device 154 is used to spray the cleaning fluid or dry gas onto the surface of the packaging structure 10. In an embodiment, the second fluid supply device 154 comprises a supply source 1541, a supply pipeline 1542, and a nozzle 1543. The supply source 1541 is used to store the cleaning fluid or dry gas. The nozzle 1543 is placed in the second chamber 151 and connected to the supply source 1541 through the supply pipeline 1542, for spraying the cleaning fluid or dry gas onto the packaging structure 10. In an embodiment, the cleaning fluid is deionized water;

the dry gas is nitrogen or inert gas.

The second pressure adjusting device 155 is used to adjust the pressure in the second chamber 151. In this embodiment, the control device 110 controls the second pressure adjusting device 155 to adjust and maintain the pressure in the second chamber 151 at atmospheric pressure, so as to perform the atmospheric-pressure cleaning process on the packaging structure 10.

In an embodiment, the second pressure adjusting device 155 is configured with an atmospheric-pressure pipeline P1. The atmospheric-pressure pipeline P1 is connected to the second chamber 151, and an exhaust valve 1551 is configured on the atmospheric-pressure pipeline P1. The control device 110 can control the exhaust valve 1551 to open, so that the second chamber 151 is connected to the atmospheric environment, the gas in the second chamber 151 is exhausted, and the pressure in the first chamber 141 is maintained at atmospheric pressure.

It should be understood that the above ranges are only exemplary implementations and do not impose any limitation on the scope of the present disclosure. Any other suitable implementations are also possible.

It should be noted that during the cleaning process of the packaging structure 10, the nozzles (1443, 1543) can be fixed or movable. The description will be given by taking the nozzle 1543 configured in the second cleaning module 150 to spray the cleaning fluid onto the packaging structure 10 as an example. In an embodiment, the nozzle 1543 sprays the cleaning fluid onto the packaging structure 10 in a stationary manner, for example, the nozzle 1543 sprays the cleaning fluid onto the packaging structure 10 from above the center of the packaging structure 10; in another embodiment, the nozzle 1543 sprays the cleaning fluid onto the packaging structure 10 in a swinging manner, for example, the nozzle 1543 swings along an arc passing through the center of the packaging structure 10 and sprays the cleaning fluid onto the packaging structure 10; in yet another embodiment, the nozzle 1543 sprays the cleaning fluid onto the packaging structure 10 in a translational manner, for example, the nozzle 1543 reciprocates along a straight line passing through the center of the packaging structure 10 and sprays the cleaning fluid onto the packaging structure 10. Similarly, when the nozzle 1543 sprays dry gas onto the packaging structure 10, the

nozzle 1543 can also be fixed or movable.

FIG. 5 shows a flowchart of an exemplary cleaning method for the packaging structure 10 according to an embodiment of the present application. The following will describe the cleaning method for the packaging structure 10 by taking the cleaning device 100 for cleaning the packaging structure 10 as an example. As shown in FIG. 5, the cleaning method for the packaging structure 10 includes a negative-pressure cleaning process S1, a pre-drying process S2, an atmospheric-pressure cleaning process S3, and a drying process S4.

The negative-pressure cleaning process S1 will be described in detail below with reference to FIGS. 2, 3, and 5.

S11: Adjust the pressure in the chamber where the packaging structure 10 is located to the preset vacuum pressure. Specifically, the control device 110 controls the manipulator 131 to place the packaging structure 10 to be cleaned in the first chamber 141 and hold the packaging structure 10 on the first chuck 142, and controls the vacuum pump 1451 to start to vacuumize the first chamber 141, so that the pressure in the first chamber 141 reaches the preset vacuum pressure. Preferably, the pressure of the first chamber 141 is adjusted to a value between 25 Torr and 150 Torr.

S12: Rotate the packaging structure 10. Specifically, the control device 110 controls the first rotating device 143 to alternately rotate the first chuck 142 at the first rotation speed and the second rotation speed, and the first rotation speed is higher than the second rotation speed, so that the packaging structure 10 rotates alternately at the first rotation speed and the second rotation speed. In some embodiments, the first rotation speed and the second rotation speed are not greater than 1000 r/min. For example, the first rotation speed ranges from 400 r/min to 800 r/min; the second rotation speed ranges from 100 r/min to 300 r/min.

It should be noted that the number of alternating cycles of the packaging structure 10 at the first rotation speed and the second rotation speed is set according to actual process conditions, for example, the number of cycles ranges from 8 to 30. In one cycle, the time for the packaging structure 10 to rotate at the first rotation speed is T1, and the time for the packaging structure 10 to rotate at the second rotation speed is T2. T1

and T2 can be set to be the same or different according to actual process conditions. For example, T1 and T2 range from 30 s to 60 s, and in a specific example, both T1 and T2 are set to 45 s.

During the negative-pressure cleaning for the packaging structure 10, rotating the packaging structure 10 at alternating speeds facilitates the removal of the cleaning fluid from the cleaning area of the packaging structure 10 (i.e., the backside of the chiplets 12), thereby preventing residual cleaning fluid.

S13: Spray the cleaning fluid at the preset temperature onto the rotating packaging structure 10 to perform the negative-pressure cleaning. Specifically, the first temperature adjusting device 146 adjusts the cleaning fluid to the preset temperature, and the cleaning fluid at the preset temperature is then sprayed via the nozzle 1443 onto the surface of the rotating packaging structure 10. Under centrifugal effect, the cleaning fluid spreads across the entire packaging structure 10. The nozzle 1443 can spray the cleaning fluid onto the packaging structure 10 in a swinging, translational, or stationary manner. In one embodiment, deionized water or saponifier-containing liquid is used as the cleaning fluid to clean the packaging structure 10. In another embodiment, cleaning is performed sequentially with saponifier-containing liquid and deionized water on the packaging structure 10. In other embodiments, saponifier-containing liquid and deionized water are used alternately to clean the packaging structure 10. Wherein, the preset temperature for both saponifier-containing liquid and deionized water can be set to a value between 40°C and 60°C, preferably 60°C. Additionally, the cleaning duration for different types of cleaning fluid can be optimized based on actual process conditions.

During the negative-pressure cleaning process S1 of the packaging structure 10, the cleaning environment of the packaging structure 10 is set to negative pressure, which can reduce the surface tension of the cleaning fluid supplied to the packaging structure 10, improve the diffusion ability of the cleaning fluid, and enable the cleaning fluid to smoothly enter the tiny gaps on the backside of the chiplets 12 and uniformly diffuse in the gaps in the bump array 13, so as to achieve a better cleaning effect.

To prevent the cleaning fluid from being vaporized before entering the cleaning area of the packaging structure 10, during the negative-pressure cleaning, the preset

vacuum pressure in the chamber where the packaging structure 10 is located should be higher than the vaporization pressure of the cleaning fluid sprayed onto the packaging structure 10 at the preset temperature, so that the cleaning fluid remains in a liquid state under the preset vacuum pressure, which is conducive to achieving a better cleaning effect. FIG. 6 shows a curve of the vaporization pressure of deionized water varying with temperature. In an embodiment, when deionized water at 60°C is used as the cleaning fluid to perform the negative-pressure cleaning on the packaging structure 10, since the vaporization pressure of deionized water at 60°C is about 150 Torr, the preset vacuum pressure in the first chamber 141 is set to no lower than 150 Torr, for example, the preset vacuum pressure in the first chamber 141 can be set to 200 Torr, so that deionized water cleans the packaging structure 10 in a liquid state.

After the packaging structure 10 completes the negative-pressure cleaning process S1 and before the packaging structure 10 is transferred to the second cleaning module 150, a pre-drying process S2 needs to be performed on the packaging structure 10 that has completed the negative-pressure cleaning process S1 in the first cleaning module 140 to thin the liquid film on the surface of the packaging structure 10, so as to prevent liquid splashing during the transfer of the packaging structure 10.

The pre-drying process S2 includes: stopping spraying the cleaning fluid onto the packaging structure 10, and rotating the packaging structure. Specifically, the nozzle 1443 is stopped from spraying the cleaning fluid onto the packaging structure 10, and the control device 110 controls the first rotating device 143 to rotate the first chuck 142, so that the packaging structure 10 rotates. Compared with the negative-pressure cleaning process S1, the pre-drying process S2 increases the rotation speed of the packaging structure 10 to remove part of the liquid film on the surface of the packaging structure 10. After the pre-drying process S2 is completed, there is still a thin liquid film on the surface of the packaging structure 10, so that the surface of the packaging structure 10 remains wet during the transfer of the packaging structure 10 to the second cleaning module 150, thereby avoiding oxidation on the surface of the packaging structure 10. In the pre-drying process S2, the rotation speed of the packaging structure 10 is lower than the rotation speed of the packaging structure 10 in the subsequent drying process S4. Specifically, in the pre-drying process S2, the rotation speed of the packaging structure 10 is lower than 1000 r/min, for example, ranging from 600 r/min

to 800 r/min.

It should be noted that after the packaging structure 10 completes the negative-pressure cleaning process S1, the control device 110 can control the vacuum breaking valve 1452 to open to break the vacuum in the first chamber 141, so that the pressure in the first chamber 141 is restored to atmospheric pressure, so as to facilitate subsequent operations such as taking out the packaging structure 10.

The atmospheric-pressure cleaning process S3 will be described in detail below with reference to FIGS. 2, 4, and 5.

S31: Adjust the pressure in the chamber where the packaging structure 10 is located to atmospheric pressure. Specifically, the control device 110 controls the manipulator 131 to transfer the packaging structure 10 cleaned in the first cleaning module 140 to the second chamber 151 of the second cleaning module 150 and hold the packaging structure 10 on the second chuck 152, and controls the exhaust valve 1551 to open, so that the pressure in the second chamber 151 is maintained at atmospheric pressure. It should be noted that if the exhaust valve 1551 of the second chamber 151 is set to be normally open, there is no need to perform the operation of opening the exhaust valve 1551 after the packaging structure 10 is transferred to the second chamber 151.

S32: Rotate the packaging structure 10. Specifically, the control device 110 controls the second rotating device 153 to rotate the second chuck 152, so that the packaging structure 10 rotates. In S32, the rotation speed of the packaging structure 10 is lower than 1000 r/min, for example, ranging from 200 r/min to 800 r/min. Preferably, in S32, the packaging structure 10 rotates at increasing rotation speed in sequence. For example, the packaging structure 10 first rotates at 300 r/min for a period of time, and then rotates at 500 r/min for a period of time.

S33: Spray deionized water onto the packaging structure 10 while the packaging structure 10 is rotating to perform atmospheric-pressure cleaning on the packaging structure 10. Specifically, the control device 110 controls the nozzle 1543 to spray deionized water onto the rotating packaging structure 10. In an embodiment, the temperature of deionized water is about 25°C.

After the packaging structure 10 completes the atmospheric-pressure cleaning process S3, a drying process S4 needs to be performed on the packaging structure 10. The drying process S41 is described below.

S41: Rotate the packaging structure 10 and increase the rotation speed of the packaging structure 10. Specifically, the control device 110 controls the second rotating device 153 to rotate the second chuck 152, so that the packaging structure 10 rotates. In S41, the rotation speed of the packaging structure 10 is no lower than 1000 r/min, for example, ranging from 1000 r/min to 3000 r/min, preferably from 1500 r/min to 2000 r/min.

S42: Purge dry gas onto the packaging structure 10 while the packaging structure 10 is rotating to dry the packaging structure 10. The dry gas can be nitrogen or inert gas. Specifically, the control device 110 controls the nozzle 1543 to purge dry gas onto the rotating packaging structure 10.

Embodiment 2

Please refer to FIG. 7. This embodiment provides a cleaning device 200 for the packaging structure. Compared with Embodiment 1, this embodiment is different in that the second cleaning module 150 is arranged at a position close to the front-end module 120.

Embodiment 3

Please refer to FIG. 8. This embodiment provides a cleaning device 300 for the packaging structure. Compared with Embodiment 1, this embodiment is different in that the cleaning device 300 is only configured with the first cleaning module 140 and not configured with the second cleaning module 150.

The structure of the first cleaning module 140 is basically the same as that in Embodiment 1. The differences will be described below with reference to FIG. 3. In Embodiment 3, the first fluid supply device 144 is used not only to spray the cleaning fluid onto the packaging structure 10 but also to spray dry gas onto the surface of the packaging structure 10. Correspondingly, the supply source 1441 is used to store the

cleaning fluid and dry gas. Secondly, in addition to the pressure reduction pipeline L1 and the vacuum breaking pipeline L2, the first pressure adjusting device 145 is also configured with an atmospheric-pressure pipeline L3. The atmospheric-pressure pipeline L3 is connected to the first chamber 141, and an exhaust valve 1453 is configured on the atmospheric-pressure pipeline L3. The control device 110 can control the exhaust valve 1453 to open, so that the gas in the first chamber 141 is exhausted to the external environment, and the pressure in the first chamber 141 is maintained at atmospheric pressure.

FIG. 9 shows a cleaning method for the packaging structure 10 implemented based on the cleaning device 300. The cleaning method only includes a negative-pressure cleaning process S01, an atmospheric-pressure cleaning process S03, and a drying process S04, wherein the negative-pressure cleaning process S01, the atmospheric-pressure cleaning process S03, and the drying process S04 are substantially the same as the negative-pressure cleaning process S1, the atmospheric-pressure cleaning process S3, and the drying process S4 in Embodiment 1, respectively. The difference is that in Embodiment 3, the negative-pressure cleaning process S01, the atmospheric-pressure cleaning process S03, and the drying process S04 are all performed in the first cleaning module 140.

For the description of performing the negative-pressure cleaning process S01 on the packaging structure 10 through the first cleaning module 140, please refer to the description of the negative-pressure cleaning process S1 in Embodiment 1. Details thereof are not described herein.

In Embodiment 3, after the control device 110 controls the first cleaning module 140 to perform the negative-pressure cleaning process S01 on the packaging structure 10, the control device 110 continues to control the first cleaning module 140 to perform the atmospheric-pressure cleaning process S03 on the packaging structure 10. According to FIG. 3, the atmospheric-pressure cleaning process S03 is: The control device 110 controls the exhaust valve 1453 to open to maintain the pressure in the first chamber 141 at atmospheric pressure, and at the same time, controls the first chuck 142 to rotate the packaging structure 10 and controls the nozzle 1443 to spray deionized water onto the rotating packaging structure 10, so as to perform atmospheric-pressure cleaning on the packaging structure 10.

After the control device 110 controls the first cleaning module 140 to perform the atmospheric-pressure cleaning process S03 on the packaging structure 10, the control device 110 continues to control the first cleaning module 140 to perform the drying process S04 on the packaging structure 10. According to FIG. 3, the drying process S04 is: The control device 110 controls the first rotating device 143 to rotate the first chuck 142, so that the packaging structure 10 rotates, and controls the nozzle 1443 to spray dry gas onto the packaging structure 10 to dry the surface of the packaging structure 10. It should be noted that during the drying process S04, the control device 110 still controls the exhaust valve 1453 to be in an open state, so that the first chamber 141 remains at atmospheric pressure.

In the drying process S04, the rotation speed of the packaging structure 10 is higher than the rotation speed of the packaging structure 10 in the negative-pressure cleaning process S01 and the atmospheric-pressure cleaning process S03. The rotation speed is increased, and dry gas is sprayed to quickly dry the packaging structure 10. Specifically, in the drying process S04, the rotation speed of the packaging structure 10 is no lower than 1000 r/min, for example, ranging from 1000 r/min to 3000 r/min, preferably from 1500 r/min to 2000 r/min.

It should be noted that in the above cleaning method, if the cleaning effect of the negative-pressure cleaning process S01 on the packaging structure 10 has met the process requirements, the atmospheric-pressure cleaning process S03 can be omitted.

In addition, the parameter settings involved in the atmospheric-pressure cleaning process S3 and the drying process S4 in Embodiment 1 can also be applied to Embodiment 3, and details thereof are not described herein.

The above embodiments merely illustrate the principles and effects of the present invention by way of example, and are not intended to limit the present invention. Any person skilled in the art may modify or alter the above embodiments without departing from the spirit and scope of the present invention. Therefore, all equivalent modifications or changes made by those with ordinary knowledge in the technical field without departing from the spirit and technical ideas disclosed in the present invention shall still be covered by the claims of the present invention.

What is claimed is:

1. A cleaning method for a packaging structure, comprising a negative-pressure cleaning process, wherein the negative-pressure cleaning process includes:

adjusting the pressure in a chamber where the packaging structure is located to a preset vacuum pressure;

rotating the packaging structure;

spraying a cleaning fluid at a preset temperature onto the rotating packaging structure to perform the negative-pressure cleaning on the packaging structure;

wherein, the preset vacuum pressure is higher than the vaporization pressure of the cleaning fluid at the preset temperature.

2. The cleaning method for the packaging structure according to claim 1, wherein the preset vacuum pressure ranges from 25 Torr to 150 Torr.

3. The cleaning method for the packaging structure according to claim 1, wherein the preset temperature ranges from 40°C to 60°C.

4. The cleaning method for the packaging structure according to claim 1, wherein the cleaning fluid has a preset spraying pressure, and the preset spraying pressure ranges from 10 psi to 70 psi.

5. The cleaning method for the packaging structure according to claim 1, wherein during the negative-pressure cleaning, the packaging structure is rotated alternately at a first rotation speed and a second rotation speed, and the first rotation speed is higher than the second rotation speed.

6. The cleaning method for the packaging structure according to claim 1, wherein the cleaning fluid comprises at least one of saponifier-containing liquid or deionized water.

7. The cleaning method for the packaging structure according to claim 1, wherein

after the negative-pressure cleaning process, a drying process is further included, comprising:

rotating the packaging structure;

purging dry gas onto the rotating packaging structure to dry the packaging structure.

8. The cleaning method for the packaging structure according to claim 7, wherein between the negative-pressure cleaning process and the drying process, an atmospheric-pressure cleaning process is further included, comprising:

adjusting the pressure in a chamber where the packaging structure is located to atmospheric pressure;

rotating the packaging structure;

spraying deionized water onto the rotating packaging structure to perform atmospheric-pressure cleaning on the packaging structure.

9. The cleaning method for the packaging structure according to claim 8, wherein when the negative-pressure cleaning process and the atmospheric-pressure cleaning process are performed on the packaging structure in different chambers, a pre-drying process performed in the same chamber as the negative-pressure cleaning process is further included between the negative-pressure cleaning process and the atmospheric-pressure cleaning process, comprising:

stopping spraying the cleaning fluid onto the packaging structure, and rotating the packaging structure;

wherein, after the pre-drying is completed for the packaging structure, the surface of the packaging structure is covered with a liquid film.

10. A cleaning device for a packaging structure, comprising a control device and at least one first cleaning module, the first cleaning module comprising:

a first chamber;

a first chuck, placed in the first chamber, for holding the packaging structure to be cleaned;

a first rotating device, for driving the first chuck to rotate;

a first fluid supply device, for spraying at least one of a cleaning fluid or dry gas onto the surface of the packaging structure;

a first pressure adjusting device, for adjusting the pressure in the first chamber;

a first temperature adjusting device, for adjusting the temperature of the cleaning fluid supplied to the first fluid supply device;

wherein, the control device is configured to control the first cleaning module to execute the cleaning method for the packaging structure according to any one of claims 1 to 8.

11. The cleaning device for the packaging structure according to claim 10, further comprising at least one second cleaning module, the second cleaning module comprising:

a second chamber;

a second chuck, placed in the second chamber, for holding the packaging structure to be cleaned;

a second rotating device, for driving the second chuck to rotate;

a second fluid supply device, for spraying at least one of deionized water or dry gas onto the surface of the packaging structure;

a second pressure adjusting device, for adjusting the pressure in the second chamber;

wherein, the control device is further configured to control the first cleaning

module to perform the negative-pressure cleaning process and the pre-drying process on the packaging structure, and control the second cleaning module to perform the atmospheric-pressure cleaning process and the drying process on the packaging structure according to the cleaning method for the packaging structure according to claim 9.