DRYING DEVICE

TECHNICAL FIELD

The present invention relates to the field of semiconductor manufacturing technology, and in particular, to a drying device.

BACKGROUND

In the process of integrated circuit manufacturing, a substrate needs to be dried after a wet etching or cleaning process. It is known that a supercritical fluid with zero surface tension can be used for drying the substrate. For example, a substrate covered with Isopropyl alcohol (IPA) is transferred from a cleaning chamber to a drying device, and the upper chamber and the lower chamber of the drying device are closed to form a sealed chamber. Then, the supercritical fluid is supplied into the sealed chamber, so that IPA on the substrate surface dissolves into the supercritical fluid, forming a mixture of IPA and the supercritical fluid. As the sealed chamber is continuously supplied with the supercritical fluid, the mixture of IPA and the supercritical fluid is continuously discharged, and the replacement between the supercritical fluid and IPA covering the substrate surface is completed, thereby achieving the purpose of removing IPA from the substrate. Subsequently, the supercritical fluid is vaporized and discharged. After the pressure within the sealed chamber returns to atmospheric pressure, the sealed chamber is opened, and the dried substrate is finally taken out.

Before the drying process is performed, the substrate covered with IPA is weighed to detect the amount of IPA liquid film. Currently, during the drying process, the support portion of the drying device moves up and moves horizontally inward toward the axis of the lower chamber to a substrate receiving position. A robot places the substrate covered with IPA on the support portion, a load cell connected to the support portion weighs the substrate, and then the support portion moves down to a substrate placing position, so that the substrate falls onto the substrate tray of the lower chamber. Then, the support portion moves horizontally outward away from the axis of the lower chamber to a retracted position, and then the lower chamber holding the substrate moves up to be closed with the upper chamber to form the sealed chamber. Wherein, the downward movement of the support portion for placing the substrate makes the

entire process time of the drying process relatively long. Moreover, when the robot places the substrate, the support portion is subjected to a force causing shaking, which in turn causes fluctuations in the load cell. The load cell may not have enough time to fully stabilize before the load cell moves down together with the support portion due to process requirements, ultimately leading to fluctuations in the detection value of the load cell and causing adverse effects.

SUMMARY

The purpose of the present invention is to solve the problems in the prior art that the movement logic of a support assembly not only makes the entire process time relatively long, but also easily leads to fluctuations in the detection value of a load cell that moves together with the support assembly.

To solve the problem described above, an embodiment of the present invention proposes a drying device, comprising:

an upper chamber;

a lower chamber, disposed below the upper chamber and provided with a substrate tray, the substrate tray being configured to hold a substrate;

a support assembly, disposed at a predetermined height, including a support portion and a driving mechanism, the driving mechanism being configured to drive the support portion to move in the horizontal direction, the support portion being configured to receive the substrate;

a detection portion, disposed on the support assembly, configured to detect the process parameter of the substrate when the support portion receives the substrate;

a lifting mechanism, disposed below the lower chamber, configured to drive the lower chamber to move in the vertical direction;

wherein, the drying device is configured such that: when the support portion moves horizontally inward toward the axis of the lower chamber to a substrate receiving position and receives the substrate, the detection portion detects the process

parameter of the substrate, the lifting mechanism drives the lower chamber to move up in the vertical direction to the substrate receiving position, so that the substrate is transferred from the support portion to the substrate tray and is supported by the substrate tray, then the support portion moves horizontally outward away from the axis of the lower chamber to a retracted position, and then the lifting mechanism continues to drive the lower chamber to move up to a process position, so that the lower chamber and the upper chamber are closed to form a sealed chamber.

An embodiment of the present invention proposes a drying device, comprising:

an upper chamber;

a lower chamber, disposed below the upper chamber and provided with a substrate tray, the substrate tray being configured to hold a substrate;

a support assembly, disposed at a predetermined height, including a support portion and a driving mechanism, the driving mechanism being configured to drive the support portion to move in the horizontal direction, the support portion being configured to receive the substrate;

a lifting mechanism, disposed below the lower chamber, configured to drive the lower chamber to move in the vertical direction;

wherein, the drying device is configured such that: when the support portion moves horizontally inward toward the axis of the lower chamber to a substrate receiving position and receives the substrate, the lifting mechanism drives the lower chamber to move up in the vertical direction from the initial position to the substrate receiving position, so that the substrate is transferred from the support portion to the substrate tray and is supported by the substrate tray, then the support portion moves horizontally outward away from the axis of the lower chamber to a retracted position, and then the lifting mechanism continues to drive the lower chamber to move up to a process position, so that the lower chamber and the upper chamber are closed to form a sealed chamber.

In the drying device of the present invention, the driving mechanism of the support assembly drives the support portion to move in the horizontal direction. When the support portion receives the substrate, the detection portion on the support assembly detects the process parameter of the substrate. At this time, the support assembly no longer performs a downward movement, but waits for the lower chamber to move up to receive the substrate, thereby shortening the entire process time of the drying process. In addition, the time during which the lower chamber moves up to receive the substrate allows the detection value of the detection portion, such as a load cell, to have sufficient time to stabilize, i.e., increase the stabilization time for the detection portion during detection.

Other features and corresponding beneficial effects of the present invention will be described in the latter part of the specification, and it should be understood that at least part of the beneficial effects will become apparent from the specification in the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present invention will be further described through the following embodiments and the accompanying drawings of the embodiments.

FIG. 1 is a schematic front view of a drying device according to an embodiment of the present application;

FIGS. 2a to 2e are partial schematic structural views of a drying device according to an embodiment of the present application;

FIG. 3 is a schematic top view of a lower chamber according to an embodiment of the present application;

FIG. 4 is a schematic view of a support assembly according to an embodiment of the present application;

FIG. 5 is a schematic front view of a lifting mechanism according to an embodiment of the present application;

FIG. 6 is a schematic bottom view of a lifting mechanism according to an embodiment of the present application; and

FIG. 7 is a schematic side view of a lifting mechanism and a guide mechanism according to an embodiment of the present application.

PREFERRED EMBODIMENTS OF THE APPLICATION

The embodiments of the present invention will be described through specific examples, and those skilled in the art can easily understand other advantages and effects of the present invention from the content disclosed in this specification. Although the description of the present invention will be introduced in conjunction with preferred embodiments, this does not mean that the features of the present invention are limited to the embodiments. On the contrary, the purpose of introducing the description in conjunction with the embodiments is to cover other options or modifications that may be extended based on the claims of the present invention. To provide a deep understanding of the present invention, many specific details will be included in the following description. The present invention may also be implemented without following these details. In addition, to avoid confusion or obscuring the focus of the present invention, some specific details will be omitted in the description. It should be noted that, in the case of no conflict, the embodiments and features in the embodiments of the present invention can be combined with each other.

It should be noted that in this specification, similar reference numerals and letters indicate similar items in the following accompanying drawings. Therefore, once an item is defined in one accompanying drawing, the item does not need to be further defined and explained in subsequent accompanying drawings.

The technical solutions of the present invention will be clearly and completely described below in conjunction with the accompanying drawings. Obviously, the described embodiments are part of the embodiments of the present invention, not all of the embodiments. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without making creative effort shall fall within the protection scope of the present invention.

In the description of the present invention, it should be noted that the terms "center," "upper," "lower," "left," "right," "vertical," "horizontal," "inner," "outer," etc. indicate orientations or positional relationships based on the orientations or positional relationships shown in the accompanying drawings. The terms are only for the convenience of describing the present invention and simplifying the description, and do not indicate or imply that the referred device or element must have a specific orientation, be constructed and operated in a specific orientation, and therefore cannot be understood as limiting the present invention. In addition, the terms "first," "second," and "third" are only used for descriptive purposes and cannot be understood as indicating or implying relative importance.

In the description of the present invention, it should be noted that, unless otherwise clearly specified and limited, the terms "mount," "interconnect," and "connect" should be understood in a broad sense. For example, the connection may be a fixed connection, a detachable connection, or an integral connection; the connection may be a mechanical connection or an electrical connection; the connection may be a direct connection or an indirect connection through an intermediate medium, and the connection may be an internal communication between two elements. Those of ordinary skill in the art can understand the specific meanings of the terms described above in the present invention according to specific circumstances.

To make the objectives, technical solutions, and advantages of the present invention clearer, the embodiments of the present invention will be further described in detail below with reference to the accompanying drawings.

FIG. 1 shows a schematic front view of a drying device according to an embodiment of the present application; FIGS. 2a to 2e show partial structural schematic views of a drying device according to an embodiment of the present application.

As shown in FIG. 1, the drying device provided in the present application comprises an upper chamber 110, a lower chamber 120, support assemblies 200, detection portions 300, and a lifting mechanism 400. The lower chamber 120 is disposed below the upper chamber 110 and is provided with a substrate tray 121. The substrate tray 121 is used for holding a substrate (not shown). The support assemblies

200 are disposed at a predetermined height. Each support assembly 200 includes a support portion 210 and a driving mechanism 223, the driving mechanism 223 is configured to drive the support portion 210 to move in the horizontal direction, and the support portion 210 is configured to receive the substrate from a robot (not shown) and transfer the substrate to the substrate tray 121 of the lower chamber 120. The detection portions 300 are disposed on the support assemblies 200 and are configured to detect the process parameter of the substrate when the support portions 210 receive the substrate. The lifting mechanism 400 is disposed below the lower chamber 120 and is configured to drive the lower chamber 120 to move in the vertical direction, so that the lower chamber 120 and the upper chamber 110 are closed or opened. In the embodiment of the present application, the detection portions 300 include load cells. The process parameter of the substrate may be the weight of the substrate. For example, before the drying process is performed on the substrate, the load cells weigh the substrate covered with IPA on the support assemblies 200 (pre-drying weighing). After the drying process is performed on the substrate, the lower chamber 120 and the upper chamber 110 are opened, and the lifting mechanism 400 drives the lower chamber 120 to move down, placing the substrate from which IPA has been removed onto the support assemblies 200. At this time, the load cells weigh the substrate on the support assemblies 200 (post-drying weighing). Based on the difference between the two weighings, the removal condition of IPA on the substrate can be known, and thus the drying status of the substrate can be known.

First, as shown in FIG. 1 and FIG. 2a, when the driving mechanisms 223 drive the support portions 210 to move horizontally inward toward the axis of the lower chamber 120 to a substrate receiving position and the support portions 210 receive the substrate 500 from the robot, the detection portions 300 detect the process parameter of the substrate 500 before drying. After the support portions 210 receive the substrate 500 from the robot, as shown in FIG. 2b, the lifting mechanism 400 drives the lower chamber 120 to move up in the vertical direction from the initial position (e.g., upward at a constant speed). When the lower chamber 120 moves to the substrate receiving position where the support portions 210 are located, the substrate 500 is transferred from the support portions 210 to the substrate tray 121 of the lower chamber 120 and is supported by the substrate tray 121. At this time, the lower chamber 120 pauses the upward movement. Then, as shown in FIG. 2c, the driving mechanisms 223 drive the

support portions 210 to move horizontally outward away from the axis of the lower chamber 120 to a retracted position, so that the support portions 210 withdraw from the lower chamber 120. After the support portions 210 withdraw from the lower chamber 120, as shown in FIG. 2d, the lifting mechanism 400 continues to drive the lower chamber 120 to move up to a process position, so that the lower chamber 120 and the upper chamber 110 are closed to form a sealed chamber 123. Inside this sealed chamber 123, the substrate 500 covered with IPA is subjected to a drying process. In existing drying devices, the support portion needs to move down to transfer the substrate to the substrate tray of the lower chamber. In contrast, in the drying device proposed in the present application, the support portions 210 do not need to move down; instead, the support portions 210 wait for the lower chamber 120 to move up to receive the substrate. Compared with existing drying devices, the drying device provided in the present application omits the downward movement of the support portions 210, thereby shortening the entire process time of the drying process. In addition, the time during which the support portions 210 wait for the lower chamber 120 to move up to receive the substrate allows the detection value of the detection portions 300 to have sufficient time to stabilize. Therefore, the time for the lower chamber 120 to move up to receive the substrate before drying overlaps with the detection time of the detection portions 300, which not only increases the stabilization time for the detection portions 300 during detection but also saves the entire process time of the drying process.

When the drying process for the substrate 500 is completed and the sealed chamber 123 is opened, the lifting mechanism 400 drives the lower chamber 120 to move down in the vertical direction from the process position to the aforementioned substrate receiving position (the position where the substrate 500 is transferred between the lower chamber 120 and the support portions 210, and also the position where the robot picks up and places the substrate 500 on the support portions 210). Then, the driving mechanisms 223 drive the support portions 210 to move horizontally inward toward the axis of the lower chamber 120 to the substrate receiving position. Next, the lifting mechanism 400 continues to drive the lower chamber 120 to move down to the initial position. During the downward movement of the lower chamber 120, the substrate 500 is transferred from the substrate tray 121 to the support portions 210 and is supported by the support portions 210. The detection portions 300 detect the process parameter of the substrate 500 after drying. After the lower chamber 120

moves down to the initial position, the robot takes away the substrate 500 on the support portions 210. Finally, the support portions 210 move horizontally outward away from the axis of the lower chamber 120 to the aforementioned retracted position. In existing drying devices, when the sealed chamber is opened, the lifting mechanism drives the lower chamber to move in the vertical direction to the initial position, then the support portions move horizontally inward to the position of the substrate tray and below the substrate, then the support portions lift the substrate and move up to the position where the robot picks up the substrate, and finally the robot takes away the substrate. In contrast, in the drying device proposed in the present application, the support portions 210 do not need to move up. Compared with existing drying devices, the drying device in the present application further omits the upward movement of the support portions 210, which can similarly shorten the entire process time of the drying process. In addition, the time during which the lower chamber 120 moves down to the initial position in the present application also allows the detection value of the detection portions 300 to have sufficient time to stabilize. Therefore, the time for the lower chamber 120 to move down to the initial position after drying overlaps with the detection time of the detection portions 300, which not only increases the stabilization time for the detection portions 300 during detection but also saves the entire process time of the drying process.

As shown in FIGS. 2a to 2e and FIG. 3, FIG. 3 shows a schematic top view of a lower chamber according to an embodiment of the present application. In some embodiments, the drying device further comprises a sealing member 124, first sensors 125, and limiting members 126. The sealing member 124 is disposed on the periphery of the substrate tray 121 and is configured to seal the sealed chamber 123. The sealing member 124 may be a spring-energized seal. The first sensors 125 are distributed on the side portions of the lower chamber 120 and are configured to monitor the chamber-closing distance between the lower chamber 120 and the upper chamber 110, so that the lower chamber 120 always moves to the same process position to be closed with the upper chamber 110 (as shown by the position of the lower chamber 120 in FIG. 2d). This protects the sealing member 124 from being crushed when the lower chamber 120 is lifted into place. The first sensors 125 may be displacement sensors. The limiting members 126 are disposed between the upper chamber 110 and the lower chamber 120. The material of the limiting members 126 needs to have a certain hardness to protect

the sealing member 124. The material of the limiting members 126 may be Polytetrafluoroethylene (PTFE). The limiting members 126 may be disposed on the lower chamber 120 or the upper chamber 110. As shown in FIG. 2d, after the lower chamber 120 moves to the process position and is closed with the upper chamber 110, a gap d is present between the upper chamber 110 and the limiting members 126. As shown in FIG. 2e, in an abnormal situation where the lower chamber 120 continues to move up after reaching the process position, the gap between the upper chamber 110 and the limiting members 126 becomes zero. The limiting members 126 can prevent the distance between the lower chamber 120 and the upper chamber 110 from being excessively small, thereby preventing the sealing member 124 from being crushed due to excessive compression.

In some embodiments, at least three first sensors 125 are provided. In the example shown in FIG. 3, three first sensors 125 are provided for monitoring the levelness of the lower chamber 120. For example, two first sensors 125 are spaced apart on a first side of the lower chamber 120, one first sensor 125 is disposed on a second side of the lower chamber 120, and the first side and the second side of the lower chamber 120 are opposite. Under the premise that the upper chamber 110 is level, when the readings of the three first sensors 125 are consistent, it indicates that the levelness of the lower chamber 120 meets the process requirement, thereby monitoring whether the lower chamber 120 is level. If the lower chamber 120 is tilted, the readings of the three first sensors 125 can quickly provide feedback, preventing the sealing member 124 from being incompletely compressed when the tilted lower chamber 120 is closed with the upper chamber 110, which can otherwise lead to poor sealing.

FIG. 4 shows a schematic view of a support assembly according to an embodiment of the present application.

In some embodiments, as shown in FIG. 4, the driving mechanism 223 of the support assembly 200 includes a sliding portion 220 and a driving portion 230. The support assembly 200 further includes a first horizontal adjustment portion 240 and a mounting portion 250. The support portion 210 of the support assembly 200 includes supporting members 211 and a connecting member 212. The supporting members 211 are connected to first ends of the connecting member 212 for supporting the substrate. Second ends of the connecting member 212 are fixed above the detection portion 300.

Wherein, the vertical distance between the end surfaces of the first ends of the connecting member 212 and the end surfaces of the second ends of the connecting member 212 is smaller than 10 cm, preferably smaller than 5 cm. This structure of the connecting member 212 helps reduce the stabilization time of the substrate when the robot just places the substrate on the supporting members 211, thereby allowing more stabilization time for the detection portion 300 during detection. Specifically, the support portion 210 includes two supporting members 211 and one connecting member 212. The two supporting members 211 are parallel to each other and horizontally spaced apart on the connecting member 212. The connecting member 212 is integrally formed. The detection portion 300 is disposed on the sliding portion 220. The support portion 210 is connected to the sliding portion 220 via the detection portion 300. The sliding portion 220 is connected to the driving portion 230. The driving portion 230 is configured to drive the sliding portion 220 to slide in the horizontal direction, thereby adjusting the horizontal distance between the support portion 210 and the substrate 500. The driving portion 230 may be a cylinder, an electric cylinder, or a linear motor, etc., preferably an electric cylinder or a linear motor with higher control precision. The first horizontal adjustment portion 240 is disposed between the driving portion 230 and the mounting portion 250. The mounting portion 250 is fixed at a predetermined height. For example, the mounting portion 250 can be fixed at a predetermined height on a machine frame (not shown). The upper chamber 110 mentioned above is also fixed on the same machine frame. In the example shown in FIG. 1, two support assemblies 200 are provided, and the mounting portions 250 of the two support assemblies 200 are respectively located on the two sides of the lower chamber 120.

With reference to FIG. 4 again, since the levelness of the support portion 210 affects the levelness of the substrate, the uniformity of IPA distribution on the substrate, and the accuracy of the reading of the detection portion 300, it is inevitable to adjust the levelness of the support portion 210 during the process. In the embodiment of the present application, the first horizontal adjustment portion 240 is used to adjust the levelness of the support portion 210. The first horizontal adjustment portion 240 is disposed between the driving portion 230 and the mounting portion 250 and is located below the detection portion 300. The first horizontal adjustment portion 240 includes a first base 241, a first fixing member 242, and a first set screw 243. The first fixing member 242 is used to fix the first base 241 onto the mounting portion 250. The first

set screw 243 is used to adjust the levelness of the first base 241. Specifically, when the levelness of the support portion 210 is adjusted via the first horizontal adjustment portion 240, the first set screw 243 is turned, which changes the gap between the first base 241 and the mounting portion 250, thereby adjusting the levelness of the first base 241. The levelness of the driving portion 230, the sliding portion 220, and the support portion 210 disposed above the first base 241 changes together with the first base 241, achieving the purpose of adjusting the levelness of the support portion 210. After the levelness of the support portion 210 is determined, the first fixing member 242 is used to fix the first base 241 onto the mounting portion 250.

In the embodiment of the present application, the first horizontal adjustment portion 240 is disposed below the detection portion 300. During the operation of adjusting the levelness, the force applied by the operator basically will not cause irreversible damage to the detection portion 300 (e.g., load cell) located above.

FIG. 5 shows a schematic front view of a lifting mechanism according to an embodiment of the present application; FIG. 6 shows a schematic bottom view of a lifting mechanism according to an embodiment of the present application. In FIG. 5, the structure related to a needle roller guide post is not shown.

In some embodiments, as shown in FIG. 1, FIG. 5, and FIG. 6, the lifting and lowering movement of the lower chamber 120 is achieved by the lifting mechanism 400. The opening and closing distance range between the lower chamber 120 and the upper chamber 110 may be 45 mm to 150 mm. The lifting mechanism 400 includes a driving device 410, a lifting platform 430, guide rails 440, second sensors 450, and a grating ruler 460. The driving device 410 is configured to drive the lifting platform 430 to move in the vertical direction. The lifting platform 430 is configured to support the lower chamber 120, so that the lower chamber 120 moves in the vertical direction. The second sensors 450 are configured to monitor the lifting position of the lifting platform 430. In the example shown in FIG. 5, four second sensors 450 are arranged from high to low. The two second sensors 4501 and 4504 at the highest and lowest positions are used to limit the maximum and minimum distances that the lifting platform 430 can travel. When reaching the highest or lowest position, the lifting platform 430 cannot continue to move up or move down. A lower-middle second sensor 4503 is used to monitor whether the lifting platform 430 has lifted the lower

chamber 120 to the substrate receiving position. After the substrate weighing is completed, the lifting platform 430 lifts the lower chamber 120 to the substrate receiving position, and the lower chamber 120 performs the substrate receiving action. An upper-middle second sensor 4502 is used to monitor whether the lifting platform 430 has lifted the lower chamber 120 to the process position where the lower chamber 120 is closed with the upper chamber 110. The second sensors 450 may be photoelectric sensors.

The grating ruler 460 is used to measure the moving distance of the lifting platform 430. As shown in FIG. 5 and FIG. 6, the driving device 410 includes a driving member 420, a driving pulley 421, a driven pulley 422, a timing belt 423, a leadscrew 424, and a movable end 425. The output end of the driving member 420 is connected to the driving pulley 421 to drive the driving pulley 421 to rotate. The timing belt 423 connects the driving pulley 421 and the driven pulley 422, so that the driving pulley 421 drives the driven pulley 422 to rotate via the timing belt 423. The driven pulley 422 is connected to the leadscrew 424 to drive the leadscrew 424 to rotate. The movable end 425 is connected to the lifting platform 430 and the guide rails 440 and is disposed on the leadscrew 424. The movable end 425 is configured to convert rotational movement into linear movement on the leadscrew 424, thereby driving the lifting platform 430 to perform linear movement in the direction of the guide rails 440. The grating ruler 460 is disposed on the movable end 425. The grating ruler 460 measures the moving distance of the lifting platform 430 by measuring the moving distance of the movable end 425.

In some embodiments, as shown in FIG. 6, the lifting mechanism 400 further includes a tensioning pulley mechanism 428 for adjusting the tightness of the timing belt 423.

FIG. 7 shows a schematic side view of a lifting mechanism and a guide mechanism according to an embodiment of the present application. It should be noted that in FIG. 1, the guide mechanism and the lifting mechanism overlap in the front-rear direction.

In some embodiments, as shown in FIG. 1 and FIG. 7, the drying device further comprises a guide mechanism. The guide mechanism includes mounting bases 471,

needle roller guide posts 472, and a second horizontal adjustment portion 474. The needle roller guide posts 472 are disposed on the mounting bases 471 and are connected to the lower chamber 120. In some embodiments, the needle roller guide posts 472 may be directly connected to the lower chamber 120 or indirectly connected. When the needle roller guide posts 472 are indirectly connected to the lower chamber 120, adapter components 473 shown in FIG. 7 may be provided at the upper ends of the needle roller guide posts 472, and the adapter components 473 are connected to the lower chamber 120. In this embodiment, two needle roller guide posts 472 are provided, respectively arranged on the two sides of the lifting platform 430. By utilizing the characteristic of the needle roller guide posts 472 capable of achieving high-precision linear movement, the lower chamber 120 is stably lifted and lowered. The second horizontal adjustment portion 474 is disposed at the bottom of the mounting bases 471 and is configured to adjust the levelness of the mounting bases 471. The second horizontal adjustment portion 474 includes second bases 4741, a second fixing member (not shown), and second set screws 4742. The mounting bases 471 are fixed to the second bases 4741. The second fixing member is used to fix the second bases 4741 at a position to be installed, e.g., fixed on the machine frame. By turning the second set screws 4742, the gap between the second bases 4741 and the machine frame can be changed, thereby adjusting the levelness of the second bases 4741, and further adjusting the levelness of the needle roller guide posts 472 and the adapter components 473, thereby further adjusting the levelness of the lower chamber 120. After the levelness of the second bases 4741 is determined, the second fixing member fixes the second bases 4741.

In some embodiments, the detection portion, e.g., load cell, and the support assembly 200 are provided independently. The detection portion may be separately arranged or integrated onto the aforementioned robot, depending on the actual process environment. In the case where the detection portion and the support assembly 200 are provided independently, this embodiment proposes a drying device. The structure of this drying device, except for the detection portion, can be referred to in FIG. 1 to FIG. 2e. The drying device of this embodiment includes an upper chamber 110, a lower chamber 120, support assemblies 200, and a lifting mechanism 400. The lower chamber 120 is disposed below the upper chamber 110 and is provided with a substrate tray 121 for holding a substrate 500. The support assemblies 200 are disposed at a

predetermined height. Each support assembly 200 includes a support portion 210 and a driving mechanism 223, the driving mechanism 223 is configured to drive the support portion 210 to move in the horizontal direction, and the support portion 210 is configured to receive the substrate 500 from a robot and transfer the substrate 500 to the substrate tray 121 of the lower chamber 120. The lifting mechanism 400 is disposed below the lower chamber 120 and is configured to drive the lower chamber 120 to move in the vertical direction, so that the lower chamber 120 and the upper chamber 110 are closed or opened.

When the driving mechanisms 223 drive the support portions 210 to move horizontally inward toward the axis of the lower chamber 120 to a substrate receiving position, the robot places the substrate 500 covered with IPA onto the support portions 210. Then, the lifting mechanism 400 drives the lower chamber 120 to move up in the vertical direction from the initial position (e.g., upward at a constant speed). When the lower chamber 120 moves to the substrate receiving position where the support portions 210 are located, the substrate 500 is transferred from the support portions 210 to the substrate tray 121 and is supported by the substrate tray 121. At this time, the lower chamber 120 pauses the upward movement. Then, the driving mechanisms 223 drive the support portions 210 to move horizontally outward away from the axis of the lower chamber 120 to a retracted position, so that the support portions 210 withdraw from the lower chamber 120. After the support portions withdraw from the lower chamber 120, the lifting mechanism 400 continues to drive the lower chamber 120 to move up to a process position, so that the lower chamber 120 and the upper chamber 110 are closed to form a sealed chamber 123. Inside this sealed chamber 123, the substrate 500 covered with IPA is subjected to a drying process. The drying device proposed in this embodiment omits the downward movement of the support portions 210, thereby shortening the entire process time of the drying process. In addition, since no downward movement is performed, the uniformity and stability of the IPA liquid film on the surface of the substrate 500 on the support portions 210 are ensured.

When the drying process for the substrate 500 is completed and the sealed chamber 123 is opened, the lifting mechanism 400 drives the lower chamber 120 to move down in the vertical direction from the process position to the substrate receiving position (the position where the substrate 500 is transferred between the lower chamber

120 and the support portions 210, and also the position where the robot picks up and places the substrate 500 on the support portions 210). Then, the driving mechanisms 223 drive the support portions 210 to move horizontally inward toward the axis of the lower chamber 120 to the substrate receiving position. Next, the lifting mechanism 400 continues to drive the lower chamber 120 to move down, so that the substrate 500 is transferred from the substrate tray 121 to the support portions 210 and is supported by the support portions 210. After the lower chamber 120 moves down to the initial position, the substrate 500 on the support portions 210 is taken away by the robot. Finally, the support portions 210 move horizontally outward away from the axis of the lower chamber 120 to the retracted position. The drying device proposed in this embodiment omits the upward movement of the support portions 210, which can similarly shorten the entire process time of the drying process.

Finally, it should be noted that the embodiments described above are only used to illustrate the technical solutions of the present invention, but not to limit them. Although the present invention has been described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that the technical solutions described in the foregoing embodiments can still be modified, or equivalent substitutions for some or all of the technical features can be made. These modifications or substitutions do not make the essence of the corresponding technical solutions depart from the scope of the technical solutions of the embodiments of the present invention.

Claims:

1. A drying device, comprising:

an upper chamber;

a lower chamber, disposed below the upper chamber and provided with a substrate tray, the substrate tray being configured to hold a substrate;

a support assembly, disposed at a predetermined height, including a support portion and a driving mechanism, the driving mechanism being configured to drive the support portion to move in the horizontal direction, the support portion being configured to receive the substrate;

a detection portion, disposed on the support assembly, configured to detect the process parameter of the substrate when the support portion receives the substrate;

a lifting mechanism, disposed below the lower chamber, configured to drive the lower chamber to move in the vertical direction;

wherein, the drying device is configured such that: when the support portion moves horizontally inward toward the axis of the lower chamber to a substrate receiving position and receives the substrate, the detection portion detects the process parameter of the substrate, the lifting mechanism drives the lower chamber to move up in the vertical direction from the initial position to the substrate receiving position, so that the substrate is transferred from the support portion to the substrate tray and is supported by the substrate tray, then the support portion moves horizontally outward away from the axis of the lower chamber to a retracted position, and then the lifting mechanism continues to drive the lower chamber to move up to a process position, so that the lower chamber and the upper chamber are closed to form a sealed chamber.

2. The drying device according to claim 1, wherein the drying device is further configured such that: when the sealed chamber is opened, the lifting mechanism drives the lower chamber to move down in the vertical direction from the process position to the substrate receiving position, the support portion moves horizontally inward toward the axis of the lower chamber to the substrate receiving position, and then the lifting

mechanism continues to drive the lower chamber to move down, so that the substrate is transferred from the substrate tray to the support portion and is supported by the support portion, the detection portion detects the process parameter of the substrate, and after the lower chamber moves down to the initial position, the substrate on the support portion is taken away, and finally the support portion moves horizontally outward away from the axis of the lower chamber to the retracted position.

3. The drying device according to claim 1, wherein the process parameter of the substrate includes the weight of the substrate, and the detection portion includes a load cell configured to detect the weight of the substrate.

4. The drying device according to claim 1, wherein the driving mechanism includes a sliding portion and a driving portion, the support assembly further includes a first horizontal adjustment portion and a mounting portion, the first horizontal adjustment portion is disposed between the driving portion and the mounting portion and is configured to adjust the levelness of the support portion, the support portion is connected to the sliding portion, the sliding portion is connected to the driving portion, the driving portion is configured to drive the sliding portion to slide in the horizontal direction, the driving portion is mounted on the mounting portion, and the mounting portion is fixed at the predetermined height.

5. The drying device according to claim 4, wherein the detection portion is disposed on the sliding portion and is located above the first horizontal adjustment portion.

6. The drying device according to claim 1, wherein the support portion includes a supporting member and a connecting member, the supporting member is connected to first ends of the connecting member for supporting the substrate, second ends of the connecting member are fixed above the detection portion; the vertical distance between the end surfaces of the first ends of the connecting member and the end surfaces of the second ends of the connecting member is smaller than 10 cm.

7. The drying device according to claim 1, wherein the drying device further comprises: a sealing member, disposed on the periphery of the substrate tray,

configured to seal the sealed chamber; first sensors, configured to monitor the chamber-closing distance between the lower chamber and the upper chamber.

8. The drying device according to claim 7, wherein at least three of the first sensors are provided, and the at least three first sensors are configured to monitor the levelness of the lower chamber.

9. The drying device according to claim 7, wherein the drying device further comprises: limiting members, disposed between the upper chamber and the lower chamber.

10. The drying device according to claim 1, wherein the lifting mechanism includes a driving device, a lifting platform, second sensors, and a grating ruler, the driving device is configured to drive the lifting platform to move in the vertical direction, the lifting platform is configured to support the lower chamber, the second sensors are configured to monitor the lifting position of the lifting platform, and the grating ruler is configured to measure the moving distance of the lifting platform.

11. The drying device according to claim 10, wherein the driving device includes a leadscrew and a movable end, the movable end is connected to the lifting platform and is disposed on the leadscrew, the movable end is configured to perform linear movement on the leadscrew, the grating ruler is disposed on the movable end, and the grating ruler measures the moving distance of the lifting platform by measuring the moving distance of the movable end.

12. The drying device according to claim 1, wherein the drying device further comprises a guide mechanism, and the guide mechanism includes: mounting bases; needle roller guide posts, disposed on the mounting bases and connected to the lower chamber.

13. The drying device according to claim 12, wherein the guide mechanism further includes: a second horizontal adjustment portion, disposed at the bottom of the mounting bases and configured to adjust the levelness of the mounting bases.

14. A drying device, comprising:

an upper chamber;

a lower chamber, disposed below the upper chamber and provided with a substrate tray, the substrate tray being configured to hold a substrate;

a support assembly, disposed at a predetermined height, including a support portion and a driving mechanism, the driving mechanism being configured to drive the support portion to move in the horizontal direction, the support portion being configured to receive the substrate;

a lifting mechanism, disposed below the lower chamber, configured to drive the lower chamber to move in the vertical direction;

wherein, the drying device is configured such that: when the support portion moves horizontally inward toward the axis of the lower chamber to a substrate receiving position and receives the substrate, the lifting mechanism drives the lower chamber to move up in the vertical direction from the initial position to the substrate receiving position, so that the substrate is transferred from the support portion to the substrate tray and is supported by the substrate tray, then the support portion moves horizontally outward away from the axis of the lower chamber to a retracted position, and then the lifting mechanism continues to drive the lower chamber to move up to a process position, so that the lower chamber and the upper chamber are closed to form a sealed chamber.

15. The drying device according to claim 14, wherein the drying device is further configured such that: when the sealed chamber is opened, the lifting mechanism drives the lower chamber to move down in the vertical direction from the process position to the substrate receiving position, the support portion moves horizontally inward toward the axis of the lower chamber to the substrate receiving position, and then the lifting mechanism continues to drive the lower chamber to move down, so that the substrate is transferred from the substrate tray to the support portion and is supported by the support portion, and after the lower chamber moves down to the initial position, the substrate on the support portion is taken away, and finally the support portion moves horizontally outward away from the axis of the lower chamber to the retracted position.