

SUBSTRATE CLAMPING DEVICE FOR SUBSTRATE CHUCK, AND JIG **AND METHOD FOR ADJUSTING THEREOF**

FIELD OF THE INVENTION

The present application relates to the field of semiconductor technology, and in particular, to a substrate clamping device for a substrate chuck, as well as a jig and a method for adjusting the substrate clamping device.

BACKGROUND

In a backside cleaning and etching process of a single-wafer substrate cleaning system, a clamping mechanism is usually adopted to clamp a substrate. The clamping mechanism is disposed in a groove of the chuck, a piston rod of the clamping mechanism is located in the groove, and the outer end of the piston rod is connected to a substrate clamping pin. The angle of the substrate clamping pin can be adjusted by moving the position of the piston rod, so as to clamp or release the substrate. When the angle of the substrate clamping pin is determined, a locking nut located in the groove fixes the position of the piston rod, thereby fixing the angle of the substrate clamping pin. However, during operation, the locking nut sometimes rotates in the groove, resulting in instability of the clamping mechanism, causing problems such as substrate tilting and poor substrate concentricity, which further lead to substrate shaking, substrate breakage, chemical liquid splashing, non-uniform etching rate at the front edge, and the like, affecting the etching effect and cleaning effect.

SUMMARY

The technical problem to be solved by the present application is the unstable clamping state of a substrate clamping mechanism during operation.

In order to solve the above technical problem, the present application provides a substrate clamping device for a substrate chuck. The substrate chuck is provided with a groove for arranging the substrate clamping device, and the groove extends along a first direction. The substrate clamping device comprises a mounting seat, a positioning portion, a driving portion, and a clamping portion, wherein the mounting seat is configured to fix the substrate clamping device to the substrate chuck; the positioning

portion is configured to be disposed in the groove, the positioning portion includes a locking member, a first push rod, and a second push rod, the first push rod and the second push rod are movably connected, and the locking member is configured to fix the relative position between the first push rod and the second push rod, wherein the positioning portion is dimensionally adapted to the groove such that the positioning portion does not rotate in the groove; the driving portion is connected to the mounting seat and configured to drive the first push rod and the second push rod to move in the groove; the clamping portion is rotatably connected to the mounting seat via a rotating shaft, the clamping portion is provided with a contact end and a connecting end, the contact end is configured to contact a substrate, the connecting end is connected to the first push rod, and when the first push rod moves, the first push rod drives the connecting end to move, and simultaneously drives the clamping portion to rotate and drives the contact end to move.

The present application further provides a jig for adjusting a substrate clamping device for solving the above technical problem, comprising a simulated chuck device and a simulated substrate device. The simulated chuck device is provided with a plurality of clamping device mounting positions, each of the clamping device mounting positions is configured to mount one substrate clamping device, and the simulated substrate device includes a simulated edge for simulating an edge of a substrate. During adjustment of the substrate clamping device, the clamping portion of each substrate clamping device is configured to clamp the simulated edge.

The present application further provides a method for adjusting a substrate clamping device for solving the above technical problem, applied to the substrate clamping device described above, comprising: adjusting the relative position between the first push rod and the second push rod, so as to adjust the rotational position of the clamping portion, such that the contact end is located at the target position and contacts an edge of the substrate; and fixing the relative position between the first push rod and the second push rod via the locking member.

In the substrate clamping device of the present application, neither the locking member nor the first push rod in the positioning portion rotates in the groove of the substrate chuck, thereby ensuring that the substrate clamping device does not shake during operation. According to the jig and method of the present application, a plurality

of substrate clamping devices can be conveniently adjusted, so that the clamping degrees of the plurality of substrate clamping devices are uniformly adjusted, ensuring stability of the substrate during subsequent processes after mounting.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present application are further described by the following embodiments and accompanying drawings of the embodiments. The accompanying drawings are provided for a better understanding of the present application, and are incorporated in and constitute a part of this application. The accompanying drawings illustrate embodiments of the present application and, together with the present specification, serve to explain the principles of the present application. In the accompanying drawings:

FIG. 1 is a schematic structural view of a substrate chuck equipped with substrate clamping mechanisms;

FIG. 2 is a side view of the substrate clamping mechanism in FIG. 1;

FIG. 3 is a schematic view of a positional relationship between a locking nut and a groove when the substrate clamping mechanism in FIG. 1 is disposed in the groove;

FIG. 4 is a cross-sectional view of a substrate clamping device for a substrate chuck according to an embodiment of the present application;

FIG. 5 is a perspective schematic view of a partial structure in the substrate clamping device in FIG. 4;

FIG. 6 is a schematic view of a positional relationship between a locking member and a groove when the substrate clamping device of the present application is disposed in the groove;

FIG. 7 is a perspective schematic view of a substrate clamping device according to another embodiment of the present application;

FIG. 8 is a cross-sectional view of the substrate clamping device in FIG. 7;

FIG. 9 is a perspective schematic view of a jig for adjusting substrate clamping devices according to an embodiment of the present application;

FIG. 10 is a cross-sectional view of the simulated chuck device and the simulated substrate device in the jig shown in FIG. 9 in a separated state;

FIG. 11 is a top view of the jig shown in FIG. 9;

FIG. 12 is a cross-sectional view taken along line CC in FIG. 11;

FIG. 13 is a perspective schematic view of a jig for a substrate clamping device according to another embodiment of the present application;

FIG. 14 and FIG. 15 are perspective schematic views of the simulated chuck device and the simulated substrate device in the jig shown in FIG. 13 in a separated state;

FIG. 16 is a top view of the jig shown in FIG. 13;

FIG. 17 is a cross-sectional view taken along line HH in FIG. 16;

FIG. 18 is an exemplary flowchart of a method for adjusting a substrate clamping device according to an embodiment of the present application;

FIG. 19 to FIG. 23 are schematic views illustrating a process of a method for adjusting a substrate clamping device according to an embodiment of the present application.

PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

In order to further clarify the technical solutions of the embodiments of the present application, the accompanying drawings required in the description of the embodiments will be briefly introduced below. Obviously, the accompanying drawings described below are only some examples or embodiments of the present application. For those of ordinary skill in the art, the present application can be applied to other similar scenarios according to these accompanying drawings without making creative efforts. Unless otherwise obvious from the context or specified otherwise, the same

reference numerals represent the same structures or operations in the drawings.

As shown in the present application, the terms "a," "an," "one," and/or "the" do not specifically refer to the singular but may include the plural unless the context clearly indicates an exception. Generally, the terms "comprise" and "include" merely suggest the inclusion of clearly identified steps and elements, and these steps and elements do not constitute an exclusive list, and a method or an apparatus may also include other steps or elements.

Unless otherwise specifically stated, the relative arrangement of components and steps, numerical expressions, and numerical values set forth in these embodiments do not limit the scope of the present application. Meanwhile, it should be understood that, for convenience of description, the dimensions of various parts shown in the accompanying drawings are not drawn according to actual proportional relationships. Technologies, methods, and apparatuses known to those of ordinary skill in the relevant art may not be discussed in detail, but where appropriate, such technologies, methods, and apparatuses should be regarded as part of the authorized specification. In all examples shown and discussed herein, any specific value should be construed as merely exemplary and not as limiting. Therefore, other examples of the exemplary embodiments may have different values. It should be noted that similar reference numerals and letters denote similar items in the following accompanying drawings, and therefore, once an item is defined in one accompanying drawing, the item does not need to be further discussed in subsequent accompanying drawings.

In the description of the present application, it should be understood that orientation terms such as "front, back, up, down, left, right," "transverse, vertical, perpendicular, horizontal," and "top, bottom" usually indicate orientations or positional relationships based on the orientations or positional relationships shown in the accompanying drawings, merely for convenience of describing the present application and simplifying the description, and in the absence of a statement to the contrary, these orientation terms do not indicate or imply that the referred device or element must have a specific orientation or be constructed and operated in a specific orientation, so these orientation terms cannot be construed as limiting the protection scope of the present application; and the orientation terms "inner, outer" refer to the inner and outer sides relative to the outline of each component itself.

For convenience of description, spatial relative terms such as "on," "above," "on an upper surface", "upper," and the like may be used herein to describe a spatial positional relationship of one device or feature relative to another device or feature as shown in the drawings. It should be understood that the spatial relative terms are intended to encompass different orientations in use or operation other than the orientation of the device described in the drawings. For example, if the device in the accompanying drawings is inverted, then a device described as "above other devices or structures" or "on other devices or structures" will be positioned as "below other devices or structures" or "under other devices or structures". Thus, the exemplary term "above" may include both orientations "above" and "below". The device may also be otherwise oriented (rotated 90 degrees or at other orientations), and the spatially relative description used herein is interpreted accordingly.

In addition, it should be noted that the use of terms such as "first" and "second" to define components is merely for distinguishing corresponding components, and unless otherwise stated, the above terms have no special meaning and therefore cannot be construed as limiting the protection scope of the present application. Furthermore, although the terms used in the present application are selected from publicly known and used terms, some terms mentioned in the present specification may be selected by the applicant according to his or her judgment, and the detailed meanings of the terms are explained in the relevant part of the description herein. In addition, it is required to understand the present application not only through the actual terms used, but also through the meaning implied by each term.

A flowchart is used in the present application to describe operations performed by a system according to embodiments of the present application. It should be understood that the operations above or below are not necessarily performed exactly in sequence. On the contrary, various steps may be processed in reverse order or simultaneously. Meanwhile, other operations may be added to these processes, or one or more steps may be removed from these processes.

FIG. 1 is a schematic structural view of a substrate chuck equipped with substrate clamping mechanisms. As shown in FIG. 1, a substrate chuck 110 is substantially a disc with a certain thickness, and a surface of the substrate chuck 110 is provided with a plurality of grooves 111, each groove 111 is provided with one substrate clamping

mechanism 120. Specifically, the substrate chuck 110 is provided with six grooves 111, each groove 111 extends in a radial direction of the substrate chuck 110 and points to the center of the chuck. Each substrate clamping mechanism 120 is disposed at the end portion of the groove 111 close to the outer periphery of the groove 111. Each end portion is provided with positioning holes 112. Each substrate clamping mechanism 120 has a mounting seat 121 and fixing members 122, and the fixing members 122 may be, for example, screws. The fixing members 122 can pass through the positioning holes 112 and be screwed tightly, so that the substrate clamping mechanisms 120 are fixed in the grooves 111 via the mounting seats 121.

FIG. 2 is a side view of the substrate clamping mechanism in FIG. 1. As shown in FIG. 2, a connecting block 123 is disposed below the mounting seat 121 of the substrate clamping mechanism 120, and the connecting block 123 is connected to a housing of a cylinder 129. The mounting seat 121 is further provided with a clamping portion 127, and the clamping portion 127 is connected to the mounting seat 121 via a rotating shaft 126. The cylinder 129 has a piston rod 124, the upper end of the clamping portion 127 is configured to directly contact a substrate during substrate clamping, and the lower end of the clamping portion 127 is connected to the piston rod 124. When the position of the piston rod 124 changes, the lower end of the clamping portion 127 is driven to move, and meanwhile, the clamping portion 127 rotates around the rotating shaft 126, so as to adjust the position of the upper end of the clamping portion 127. Specifically, the piston rod 124 usually includes two push rod sections, one is an internal push rod section 124a partially located inside the cylinder 129, and the other is an external push rod section 124b located outside the cylinder 129. The two push rod sections are movably connected and locked to each other via a locking nut 125, so as to define the length of the piston rod 124 and the clamping position or the release position of the clamping portion 127. In FIG. 2, when the cylinder 129 is ventilated, the internal push rod section 124a moves rightward and drives the external push rod section 124b to move rightward, so that the clamping portion 127 moves leftward to the clamping position to clamp the substrate. FIG. 3 shows a schematic view of the positional relationship between the locking nut 125 and the groove 111 when the substrate clamping mechanism 120 is disposed in the groove 111. Since dimensions of the locking nut 125 and the piston rod 124 are relatively small, the locking nut 125 may self-rotate during long-time operation, resulting in loosening between the two

push rod sections of the piston rod 124, changing the length of the piston rod 124, which will lead to a change in the clamping position of the clamping portion 127, causing unstable substrate clamping and adverse consequences such as substrate shaking, substrate breakage, chemical liquid splashing, and non-uniform etching rate at the front edge.

FIG. 4 is a cross-sectional view of a substrate clamping device for a substrate chuck according to an embodiment of the present application. A substrate clamping device 400 of the present application can be disposed in the groove 111 of the substrate chuck 110 shown in FIG. 1, and therefore will be described below with reference to the substrate chuck 110 in FIG. 1. However, the present application does not limit the extending direction of the groove 111, which is not limited to FIG. 1, and the extending direction of the groove 111 is defined as a first direction. In addition, it should be noted that the substrate includes a wafer, but the shape of the substrate is not limited to a circle and may be any shape, and therefore, the shape of the substrate chuck 110 is adapted to the shape of the substrate to be processed.

According to FIG. 4, the substrate clamping device 400 comprises a mounting seat 410, a positioning portion 420, a clamping portion 430, and a driving portion 440, wherein the mounting seat 410 is configured to fix the substrate clamping device 400 as a whole to the substrate chuck 110. The mounting seat 410 is structurally adapted to the groove 111, for example, similarly to the structure shown in FIG. 1, the mounting seat 410 can be fixedly disposed in the groove 111 through cooperation between the fixing members 122 and the positioning holes 112 on the groove 111. The positioning portion 420 includes a locking member 421, a first push rod 422, and a second push rod 423, the first push rod 422 and the second push rod 423 are movably connected (e.g., threadedly connected), and the locking member 421 is configured to fix the relative position between the first push rod 422 and the second push rod 243, wherein the positioning portion 420 is dimensionally adapted to the groove 111 such that the positioning portion 420 does not rotate in the groove 111. The clamping portion 430 is rotatably connected to the mounting seat 410 via a rotating shaft 431, the clamping portion 430 has a contact end 432 and a connecting end 433, the contact end 432 is configured to contact the substrate, the connecting end 433 is connected to the first push rod 422, and when the first push rod 422 moves, the first push rod 422 drives the

connecting end 433 to move, and simultaneously drives the clamping portion 430 to rotate and drives the contact end 432 to move. A connecting member 411 is disposed below the mounting seat 410, and the driving portion 440 is fixed below the mounting seat 410 via the connecting member 411. After assembly, the positioning portion 420 and the driving portion 440 are both located in the groove 111, and the driving portion 440 is configured to drive the first push rod 422 and the second push rod 423 to move in the groove 111 along the first direction.

In this embodiment, the driving portion 440 is embodied as a cylinder. As shown in FIG. 4, one end of the second push rod 423 is disposed inside the cylinder, and the other end of the second push rod 423 is connected to the first push rod 422. When the cylinder is ventilated, the second push rod 423 is pushed to move rightward, a spring 441 is compressed, and since the right end of the second push rod 423 abuts against the interior of the first push rod 422, the first push rod 422 can also be pushed to move rightward. In this example, the first push rod 422 is threadedly connected to the outer periphery of the second push rod 423, so that the relative position between the first push rod 422 and the second push rod 423 can be adjusted by rotating a piston end 422a of the first push rod 422. In FIG. 4, the locking member 421 is sleeved on the outer periphery of the second push rod 423, and after the relative position between the first push rod 422 and the second push rod 423 is determined, the first push rod 422 can be locked via the locking member 421, so that the relative position between the first push rod 422 and the second push rod 423 is fixed. The first push rod 422 and the second push rod 423 together form a piston rod.

It should be noted that the adoption of the cylinder as the driving portion 440 is one implementation for driving the first push rod 422 and the second push rod 423 to move, and in other embodiments, other mechanical devices can be adopted as the driving portion to drive the first push rod 422 and the second push rod 423 to move.

FIG. 5 shows a perspective schematic view of a partial structure in the substrate clamping device in FIG. 4, comprising the locking member 421, the first push rod 422, and the clamping portion 430. Wherein, the locking member 421 is embodied as a locking nut, such as a hexagonal nut. The locking member 421 is disposed at one end 427 of the first push rod 422, specifically the end away from the piston end 422a. The locking member 421 is also disposed on the outer periphery of the second push rod

423. When the relative position between the first push rod 422 and the second push rod 423 is determined, the locking member 421 is locked to fix the relative position between the first push rod 422 and the second push rod 423.

As shown in FIG. 4, in some embodiments, the first push rod 422 has a threaded hole 424, the second push rod 423 is threadedly connected in the threaded hole 424, the second push rod 423 further has an external thread, and the locking member 421 locks the first push rod 422 or the second push rod 423 via the external thread to fix the relative position between the first push rod 422 and the second push rod 423.

In some embodiments, as shown in FIG. 5, the locking member 421 and the first push rod 422 are fixedly connected by first fixing members 428. Specifically, the first fixing members 428 can be set screws.

FIG. 6 shows the positional relationship between the locking member 421 and the groove 111 when the substrate clamping device 400 of the present application is disposed in the groove 111. In this embodiment, the locking member 421 has a first height $H1$ and a first width $W1$, the groove 111 has a groove depth $H0$ and a groove width $W0$, and the first width $W1$ is adapted to the groove width $W0$, i.e., the first width $W1$ is smaller than or equal to the groove width $W0$, so that the locking member 421 cannot rotate relative to the groove 111. When $W1=W0$ is designed, due to tolerances and other reasons, the locking member 421 and the inner walls of the groove 111 may not be completely attached but have a certain gap. The adaptation of the first width $W1$ to the groove width $W0$ means that the gap is sufficiently small to ensure that the locking member 421 does not rotate relative to the groove 111.

In some embodiments, the first height $H1$ can be greater than the groove depth $H0$, so that the locking member 421 protrudes out of the groove 111. It should be noted that the bottom of the locking member 421 usually does not contact the bottom of the groove 111.

In some embodiments, the locking member 421 has two oppositely disposed parallel surfaces 425 and 426, and both parallel surfaces 425 and 426 are parallel to the groove walls of the groove 111. The first width $W1$ is the distance between the two parallel surfaces 425 and 426. Such an arrangement further ensures that the locking

member 421 does not rotate in the groove 111.

According to FIG. 5, the first push rod 422 has substantially the same height and width as the locking member 421. However, the first push rod 422 and the locking member 421 may be different in outline shape.

In some embodiments, the cross-sectional area of the first push rod 422 is smaller than or equal to the cross-sectional area of the locking member 421, so that when the first push rod 422 and the locking member 421 are both disposed in the groove 111, since the locking member 421 and the first push rod 422 are locked to each other and do not rotate relative to each other when the first push rod 422 is fixed in position, the first push rod 422 can also be prevented from rotating in the groove 111 by setting the first width of the locking member 421.

In some embodiments, the first push rod 422 has two oppositely disposed parallel surfaces, both parallel surfaces are parallel to the groove walls of the groove 111 with reference to FIG. 5. Such an arrangement further ensures that the first push rod 422 does not rotate in the groove 111.

In other embodiments, the first push rod 422 has a second height H_2 and a second width W_2 , the groove 111 has a groove depth H_0 and a groove width W_0 , and the second width W_2 is adapted to the groove width W_0 , so that the first push rod 422 does not rotate in the groove 111. In these embodiments, the dimension of the locking member 421 can be smaller than the dimension of the first push rod 422, and the locking member 421 is also prevented from rotating by preventing the first push rod 422 from rotating.

In some embodiments, the second height H_2 is greater than the groove depth H_0 .

In some embodiments, dimensions and shapes of the first push rod 422 and the locking member 421 are respectively set to ensure that the first push rod 422 and the locking member 421 do not rotate in the groove 111.

It should be noted that since the first push rod 422 is sleeved on the outer periphery of the second push rod 423, the cross-sectional area of the first push rod 422 is larger than the cross-sectional area of the second push rod 423. The dimension of the first

push rod 422 and/or the locking member 421 can be used to represent the maximum outer dimension of the positioning portion 420. By setting the dimension of the first push rod 422 and/or the locking member 421 to be adapted to the groove 111, the positioning portion 420 as a whole can be ensured not to rotate in the groove 111, and the second push rod 423 can also be ensured not to rotate. In other embodiments, the right end of the second push rod 423 can be set to a structure similar to the left end of the first push rod 422, and the right end of the second push rod 423 is sleeved on the outer periphery of the first push rod 422 with a smaller dimension, so that the dimension of the right end of the second push rod 423 can be set to be adapted to the dimension of the groove 111, so that the positioning portion 420 does not rotate in the groove 111.

FIG. 7 and FIG. 8 respectively show a perspective schematic view and a cross-sectional view of a substrate clamping device according to another embodiment of the present application. Similar to the embodiment shown in FIG. 4, the substrate clamping device 700 of this embodiment also comprises a mounting seat 710, a positioning portion 720, a clamping portion 730, and a driving portion 750, wherein the driving portion 750 is embodied as a cylinder. The mounting seat 710 is connected to the driving portion 750 via a connecting block 711, specifically, the connecting block 711 is connected to the housing of the cylinder, a second push rod 740 in the positioning portion 720 is partially located in the cylinder, the second push rod 740 is movably connected to a first push rod 722, and a locking member 721 is sleeved on the second push rod 740 for locking the first push rod 722 and the second push rod 740. Wherein, the positioning portion 720 further includes a sleeve 723, and the sleeve 723 wraps around the peripheries of the locking member 721 and the first push rod 722. When the positioning portion 720 is disposed in the groove 111, the sleeve 723 is disposed in the groove 111 and does not rotate.

In some embodiments, the sleeve 723 has a third height $H3$ and a third width $W3$, the groove 111 has a groove depth $H0$ and a groove width $W0$, and the third width $W3$ is adapted to the groove width $W0$, so that the sleeve 723 does not rotate in the groove 111.

In some embodiments, the third height $H3$ is greater than the groove depth $H0$.

Similar to the locking member 421 and the first push rod 422, the sleeve 723 can be provided with two oppositely disposed parallel surfaces, FIG. 7 shows one of the parallel surfaces denoted by reference numeral 724, and both parallel surfaces are parallel to the groove walls of the groove 111.

As shown in FIG. 7, the sleeve 723 further includes at least one fixing member 725 penetrating the wall of the sleeve 723 and configured to fix the sleeve 723 to the outer side of the locking member 721 or the first push rod 722. Specifically, the fixing member 725 can be a set screw.

As shown in FIG. 8, a part of the first push rod 722 is located inside the sleeve 723. As shown in FIG. 8, the inner end of the fixing member 725 contacts the outer surface of the first push rod 722 for directly fixing the relative position between the first push rod 722 and the sleeve 723. In other embodiments, the inner end of the fixing member 725 can also contact the outer surface of the locking member 721 to directly fix the locking member 721 and the sleeve 723.

As shown in FIG. 8, in this embodiment, the first push rod 722 has a threaded hole 726, the second push rod 740 is threadedly connected in the threaded hole 726, and the locking member 721 is disposed on the outer periphery of the second push rod 740 for locking the first push rod 722 or the second push rod 740 to fix the relative position between the first push rod 722 and the second push rod 740. The present application does not limit how the locking member 721 performs locking. As shown in FIG. 8, in this embodiment, the locking member 721 has an internal thread, and the second push rod 740 is also threadedly connected to the locking member 721.

As shown in FIG. 7 and FIG. 8, the cylinder serving as the driving portion 750 is connected to a gas source via a gas interface 751. A part of the second push rod 740 is disposed in the inner space of the cylinder 750, and a spring 752 is disposed on the outer periphery of the second push rod 740. When the cylinder operates, the second push rod 740 is forced to move along the first direction and compress or stretch the spring 752. According to such an embodiment, the cylinder can be used to control a position of the second push rod 740 in the groove 111, so as to control the position of the first push rod 722, and further control the position of the clamping portion 730, so that the substrate clamping device 700 can clamp or release the substrate as required,

and the positioning portion 720 does not rotate in the groove 111 during long-time operation, ensuring stable substrate clamping.

Before the above substrate clamping device is used, the substrate clamping device usually needs to be adjusted to determine the position of the clamping portion, so as to effectively clamp the substrate. The present application further provides a jig for adjusting the above substrate clamping device.

FIG. 9 is a perspective schematic view of a jig for substrate clamping devices according to an embodiment of the present application. FIG. 10 is a cross-sectional view of the simulated chuck device and the simulated substrate device in the jig shown in FIG. 9 in a separated state. FIG. 11 is a top view of the jig shown in FIG. 9. FIG. 12 is a cross-sectional view taken along line CC in FIG. 11. With reference to FIG. 9 to FIG. 12, a jig 900 comprises a simulated chuck device 910 and a simulated substrate device 920. The simulated chuck device 910 is provided with a plurality of clamping device mounting positions 911, each clamping device mounting position 911 is configured to mount one substrate clamping device 930, and the simulated substrate device 920 includes a simulated edge 921 for simulating the edge of the substrate. During adjustment of the substrate clamping devices 930, a clamping portion 931 of each substrate clamping device 930 is configured to clamp the simulated edge 921. In this embodiment, six substrate clamping devices 930 are included and evenly spaced on the circumference of the substrate chuck. It should be noted that the jig 900 of the present application can adjust the substrate clamping devices described above in the present application, and can also be used to adjust existing or any other substrate clamping devices.

As shown in FIG. 9 and FIG. 10, each substrate clamping device 930 can be fixedly mounted on the simulated chuck device 910 by a plurality of fixing blocks 941, 942, and 943, and the present application does not limit a specific mounting manner. It should be noted that the simulated chuck device 910 has the same shape and size as the actual substrate chuck, and the clamping device mounting positions 911 are the same as the mounting positions of the substrate clamping devices in an actual process. The distance or height between the simulated chuck device 910 and the simulated substrate device 920 is also the same as an actual process requirement. It should be noted that in use, the simulated substrate device 920 can be disposed on a horizontal

table to ensure that each substrate clamping device 930 is located on the same horizontal plane.

As shown in FIG. 10, a first centering portion is disposed at the center of the simulated chuck device 910, specifically a positioning groove 912, and a second centering portion is disposed at the center of the simulated substrate device 920, specifically a positioning protrusion 922. The positioning groove 912 and the positioning protrusion 922 can cooperate with each other, so that the simulated chuck device 910 and the simulated substrate device 920 are centered.

As shown in FIG. 10, the simulated edge 921 is a circular edge similar to the substrate edge, and is configured to engage contact ends 932 on the clamping portions 931. The simulated edge 921 has the same shape as the substrate to be simulated. During adjustment, the relative position between the first push rod and the second push rod in each positioning portion 933 is adjusted so that the contact end 932 just contacts the simulated edge 921, then the relative position between the first push rod and the second push rod is fixed by the locking member in each positioning portion 933, the substrate clamping devices 930 are detached from the simulated chuck device 910 and mounted on an actual substrate chuck, and at this time, the clamping state of the substrate clamping devices 930 for the substrate is the same as the clamping state for the jig.

As shown in FIG. 12, the simulated edge 921 has a diameter D . In some embodiments, the diameter D of the simulated edge 921 is smaller than the actual diameter of the substrate to be simulated, and is used to adjust the positions of the clamping portions when the substrate clamping devices are in a substrate clamping state. In other embodiments, the diameter D of the simulated edge 921 is larger than the actual diameter of the substrate to be simulated, and is used to adjust the positions of the clamping portions when the substrate clamping devices are in a substrate releasing state.

With reference to FIG. 9 and FIG. 12, in this embodiment, the simulated chuck device 910 is located above the simulated substrate device 920, and the clamping portions 931 protrude downward to clamp the simulated edge 921.

FIG. 13 is a perspective schematic view of a jig for substrate clamping devices according to another embodiment of the present application. FIG. 14 and FIG. 15 are perspective schematic views of the simulated chuck device and the simulated substrate device in the jig shown in FIG. 13 in a separated state. FIG. 16 is a top view of the jig shown in FIG. 13. FIG. 17 is a cross-sectional view taken along line HH in FIG. 16. With reference to FIG. 13 to FIG. 17, a jig 1300 comprises a simulated chuck device 1310 and a simulated substrate device 1320. The simulated chuck device 1310 is provided with a plurality of clamping device mounting positions 1311, each clamping device mounting position 1311 is configured to mount one substrate clamping device 1330, and the simulated substrate device 1320 includes a simulated edge 1321 for simulating the substrate edge. During adjustment of the substrate clamping devices 1330, a clamping portion 1331 of each substrate clamping device 1330 is configured to clamp the simulated edge 1321. FIG. 13 shows a plurality of fixing blocks 1341 and 1342 for fixedly mounting each substrate clamping device 1330 on the simulated chuck device 1310. FIG. 13 also shows a plurality of support legs 1340 for supporting the simulated chuck device 1310. It should be noted that the plurality of support legs 1340 should have the same height, so that the simulated chuck device 1310 is horizontal, thereby ensuring that each mounted substrate clamping device 1330 is located on the same horizontal plane.

As shown in FIG. 15, in this embodiment, the first centering portion at the center of the simulated chuck device 1310 is positioning holes 1312 and 1313, and the second centering portion at the center of the simulated substrate device 1320 is positioning shafts 1322 and 1323. During cooperation, the positioning hole 1312 is in clearance fit with the positioning shaft 1322, and the positioning hole 1313 is in threaded fit with the positioning shaft 1323, so that the simulated chuck device 1310 and the simulated substrate device 1320 are centered.

In other embodiments, the first centering portion can be positioning shafts, and the second centering portion can be positioning holes.

As shown in FIG. 14 and FIG. 17, the surface of the simulated chuck device 1310 facing the simulated substrate device 1320 is provided with a plurality of adjusting posts 1350 for adjusting the distance d between the simulated chuck device 1310 and the simulated substrate device 1320. The distance d can be adjusted according to actual

needs. After the distance d is adjusted, the first centering portion and the second centering portion are locked to fix the distance d .

According to the jig of the present application, the relative position between the first push rod and the second push rod in each positioning portion can be conveniently adjusted, so as to adjust the position of the clamping portion in each substrate clamping device when clamping the substrate or releasing the substrate, and the relative position between the first push rod and the second push rod is fixed by the locking member in each positioning portion.

FIG. 18 is an exemplary flowchart of a method for adjusting a substrate clamping device according to an embodiment of the present application. The adjusting method can be used to adjust the substrate clamping device, and can be adjusted on the jig described above. All of the contents about the substrate clamping device and the jig described above can be used to explain the adjusting method. However, the adjusting method can also be directly performed on the actual substrate chuck and substrate. As shown in FIG. 18, the adjusting method of this embodiment comprises the following steps:

Step S1810: adjusting the relative position between the first push rod and the second push rod, so as to adjust the rotational position of the clamping portion, such that the contact end is located at the target position and contacts an edge of the substrate;

Step S1820: fixing the relative position between the first push rod and the second push rod via the locking member.

The above steps will be described below with reference to FIG. 19 and FIG. 20.

FIG. 19 to FIG. 23 are schematic views illustrating a process of a method for adjusting a substrate clamping device, specifically a process for adjusting a position of a clamping portion when a substrate clamping device 1900 is in a substrate clamping state, wherein the substrate clamping device 1900 shown is merely an example, and the method steps can be implemented using the jig 900 shown in FIG. 9. Since the jig 900 is used, the substrate edge in Steps S1810 and S1820 is the simulated edge 921. As shown in FIG. 19, initially, the substrate clamping device 1900 is mounted to the

clamping device mounting position on the jig, and at this time, a large gap G1 is formed between a contact end 1931 of a clamping portion 1930 and the simulated edge 921. For an embodiment including a cylinder, a cylinder 1950 is in a non-ventilated state at this time, and under an action force of a spring 1952, the left end 1941 of a second push rod 1940 abuts against the left side 1951 in the inner space of the cylinder 1950, so that the clamping portion 1930 is in the maximum release state. As shown in FIG. 20, after the cylinder 1950 is ventilated, the second push rod 1940 and a first push rod 1920 move rightward, the spring 1952 is compressed, and the left end 1941 of the second push rod 1940 abuts against the right side 1953 in the inner space of the cylinder 1950. At this time, the contact end 1931 may or may not contact the simulated edge 921. In the example shown in FIG. 20, the contact end 1931 does not contact the simulated edge 921, specifically, a gap G2 is formed between the contact end 1931 and the simulated edge 921 at this time, and the gap G2 is smaller than the gap G1. At this time, Step S1810 comprises:

Step S1811: Adjusting the position of the locking member 1921 to lock the position of the second push rod 1940. As shown in FIG. 21, this step specifically includes moving the locking member 1921 to the right end 1954 of the cylinder 1950, and locking the position of the second push rod 1940 at this position.

Step S1812: Moving the first push rod 1920, so that the contact end 1931 contacts the simulated edge 921. As shown in FIG. 22, the first push rod 1920 is moved rightward, so that the sum L of lengths of the first push rod 1920 and the second push rod 1940 is further increased, and meanwhile the contact end 1931 is driven to move leftward. It should be noted that since substrate clamping requires a plurality of substrate clamping devices, each substrate clamping device is adjusted individually or simultaneously in this step, so that each contact end 1931 contacts the simulated edge 921.

Step S1813: When the contact end 1931 contacts the simulated edge 921, stopping adjusting the position of the first push rod 1920. FIG. 22 shows a gap G3 indicating that the contact end 1931 just contacts the simulated edge 921, and the distance of the gap G3 in a horizontal direction can be zero or a small value greater than zero, for example, a value from 0.02 to 0.03 mm.

During adjustment using the simulated substrate device, for example, if the actual diameter of the substrate is 300 mm, the diameter of the simulated edge can be designed to be 299.6 mm, so that a sufficient and stable clamping force during use can be ensured.

A process of adjusting the position of the clamping portion when the substrate clamping device 1900 is in a substrate releasing state is similar to the above process.

In these embodiments, Step S1820 is embodied as: moving the locking member 1921 to the end portion 1922 of the first push rod 1920 close to the locking member 1921, and locking the locking member 1921. As shown in FIG. 23, the locking member 1921 abuts against the end portion 1922 of the first push rod 1920, and fixes the first push rod 1920 at this position, completing adjustment of the rotational position of the clamping portion 1930. In this step, since the locking member 1921, the first push rod 1920, and the second push rod 1940 are all threadedly connected, and the cylinder stops ventilation, the relative position between the first push rod 1920 and the second push rod 1940 will not change.

According to the substrate clamping devices, the jig for adjusting the substrate clamping devices, and the adjusting method of the present application, the clamping degrees of a plurality of substrate clamping devices to be used can be uniformly adjusted before mounting, ensuring stability of the substrate during the process after mounting.

The basic concepts have been described above. Obviously, for those skilled in the art, the above disclosure is merely an example and does not constitute a limitation to the present application. Although not explicitly stated herein, those skilled in the art may make various modifications, improvements, and amendments to the present application. Such modifications, improvements, and amendments are suggested in the present application, so such modifications, improvements, and amendments still belong to the spirit and scope of the exemplary embodiments of the present application.

Meanwhile, specific terms are used in the present application to describe the embodiments of the present application. For example, "one embodiment," "an embodiment," and/or "some embodiments" mean a certain feature, structure, or characteristic related to at least one embodiment of the present application. Therefore,

it should be emphasized and noted that "an embodiment" or "one embodiment" or "an alternative embodiment" mentioned twice or more in different positions in this specification does not necessarily refer to the same embodiment. Furthermore, certain features, structures, or characteristics of one or more embodiments of the present application can be appropriately combined.

Similarly, it should be noted that in order to simplify the disclosure of the present application and help understand one or more of the inventive embodiments, in the above description of the embodiments of the present application, various features are sometimes combined into one embodiment, accompanying drawing, or description thereof. However, such a disclosure method does not mean that the object of the present application requires more features than those mentioned in the claims. In fact, the features of the embodiments are fewer than all the features of the single embodiment disclosed above.

In some embodiments, reference numerals are used to identify components and attributes, and it should be understood that such numbers used for describing the embodiments are modified by the modifier "about," "approximately," or "substantially" in some examples. Unless otherwise stated, the modifier "about," "approximately," or "substantially" indicates that a variation of $\pm 20\%$ is allowed for the numbers. Accordingly, in some embodiments, numerical parameters used in the present application are approximate values, and the approximate values can be changed according to characteristics required by individual embodiments. In some embodiments, the numerical parameters should consider specified effective digits and adopt a general digit retention method. Although numerical ranges and parameters for confirming the breadth of the scope in some embodiments of the present application are approximate values, in specific embodiments, such numerical values are set as precisely as possible within a feasible range.

What is claimed is:

1. A substrate clamping device for a substrate chuck, wherein the substrate chuck is provided with a groove for disposing the substrate clamping device, and the groove extends along a first direction, comprising:

a mounting seat, configured to fix the substrate clamping device to the substrate chuck;

a positioning portion, configured to be disposed in the groove, including a locking member, a first push rod, and a second push rod, the first push rod and the second push rod being movably connected, and the locking member being configured to fix the relative position between the first push rod and the second push rod, wherein the positioning portion is dimensionally adapted to the groove such that the positioning portion does not rotate in the groove;

a driving portion, connected to the mounting seat, and configured to drive the first push rod and the second push rod to move in the groove;

a clamping portion, rotatably connected to the mounting seat via a rotating shaft, provided with a contact end and a connecting end, the contact end being configured to contact a substrate, the connecting end being connected to the first push rod, and when the first push rod moves, the first push rod driving the connecting end to move, and simultaneously driving the clamping portion to rotate and driving the contact end to move.

2. The substrate clamping device according to claim 1, wherein the locking member has a first width, the groove has a groove width, and the first width is adapted to the groove width such that the locking member does not rotate in the groove.

3. The substrate clamping device according to claim 2, wherein the locking member has two oppositely disposed parallel surfaces, and both parallel surfaces are parallel to the groove walls of the groove.

4. The substrate clamping device according to claim 1 or 2, wherein the first push rod has a second width, the groove has a groove width, and the second width is adapted

to the groove width such that the first push rod does not rotate in the groove.

5. The substrate clamping device according to claim 4, wherein the first push rod has two oppositely disposed parallel surfaces, and both parallel surfaces are parallel to the groove walls of the groove.

6. The substrate clamping device according to claim 1, wherein the positioning portion further includes a sleeve wrapping around the peripheries of the locking member and the first push rod and disposed in the groove, and the sleeve is dimensionally adapted to the groove such that the sleeve does not rotate in the groove.

7. The substrate clamping device according to claim 6, wherein the sleeve has a third width, the groove has a groove width, and the third width is adapted to the groove width such that the sleeve does not rotate in the groove.

8. The substrate clamping device according to claim 6, wherein the sleeve has two oppositely disposed parallel surfaces, and both parallel surfaces are parallel to the groove walls of the groove.

9. The substrate clamping device according to claim 6, wherein a part of the first push rod is located inside the sleeve.

10. The substrate clamping device according to claim 6, wherein the sleeve further includes at least one fixing member penetrating the wall of the sleeve and configured to fix the sleeve to the outer side of the locking member or the first push rod.

11. The substrate clamping device according to claim 1, wherein the first push rod has a threaded hole, the second push rod is threadedly connected in the threaded hole, and the locking member is disposed on the outer periphery of the second push rod.

12. A jig for adjusting a substrate clamping device, wherein the jig comprises a simulated chuck device and a simulated substrate device, the simulated chuck device is provided with a plurality of clamping device mounting positions, each of the clamping device mounting positions is configured to mount one substrate clamping device, the simulated substrate device includes a simulated edge for simulating an edge of a substrate, and during adjustment of the substrate clamping device, the clamping

portion of each substrate clamping device is configured to clamp the simulated edge.

13. The jig according to claim 12, wherein a first centering portion is disposed at the center of the simulated chuck device, a second centering portion is disposed at the center of the simulated substrate device, and the first centering portion and the second centering portion are cooperatively arranged.

14. The jig according to claim 12, wherein the surface of the simulated chuck device facing the simulated substrate device is provided with a plurality of adjusting posts for adjusting the distance between the simulated chuck device and the simulated substrate device.

15. The jig according to claim 12, wherein the simulated chuck device is located below the simulated substrate device, and the clamping portion protrudes upward to clamp the simulated edge.

16. The jig according to claim 12, wherein the simulated chuck device is located above the simulated substrate device, and the clamping portion protrudes downward to clamp the simulated edge.

17. The jig according to claim 12, wherein the diameter of the simulated edge is smaller than the actual diameter of the simulated substrate, and is used to adjust the position of the clamping portion when the substrate clamping device is in a substrate clamping state.

18. The jig according to claim 12, wherein the diameter of the simulated edge is larger than the actual diameter of the simulated substrate, and is used to adjust the position of the clamping portion when the substrate clamping device is in a substrate releasing state.

19. A method for adjusting a substrate clamping device, applied to the substrate clamping device according to any one of claims 1 to 11, comprising:

adjusting the relative position between the first push rod and the second push rod, so as to adjust the rotational position of the clamping portion, such that the contact end is located at the target position and contacts an edge of the substrate;

fixing the relative position between the first push rod and the second push rod via the locking member.