SUBSTRATE TRANSFER APPARATUS AND SUBSTRATE PROCESSING APPARATUS

FIELD OF THE INVENTION

The present invention relates to the field of semiconductors, and specifically relates to a substrate transfer apparatus and a substrate processing apparatus.

BACKGROUND

In substrate processing procedures such as substrate annealing treatment, a robot is used to rotate, pick, and place a substrate. Such treatment has two requirements: First, the robot structure should be simple; second, the movement of the robot should be stable. A complex robot design will increase costs and increase assembly difficulties for the robot at the same time. If the robot generates jitter during ascending, descending, and rotating movements, impacts will be imposed on substrate placement. Minor defects include uneven substrate placement, while severe defects include substrate damage caused by robot jitter. Therefore, it is necessary to design a robot with a simple structure and stable movement performance.

SUMMARY

The present application aims to provide a substrate transfer apparatus and a substrate processing apparatus. The substrate transfer apparatus and the substrate processing apparatus can reduce the fitting tolerance requirements for perpendicularity and concentricity between a plurality of guide shafts and a support base, and reduce the machining cost of the support base. Furthermore, the substrate transfer apparatus and the substrate processing apparatus of the present application can ameliorate the tilting phenomenon of the robot.

To address the above technical problem, the present application provides a substrate transfer apparatus, comprising: a support column; a robot, configured to support a substrate; a lifting mechanism, including a lifting drive device and lifting support members, wherein the lifting drive device is configured to drive the lifting support members to ascend and descend, the lifting support members include a first support member, and the first support member is fixedly connected to the robot, so as

to drive the robot to perform ascending and descending movements; a rotating mechanism, including a support base, wherein the rotating mechanism is rotatably connected to the support column via the support base, and the rotating mechanism is configured to drive the robot and the first support member to rotate around the support column; and a plurality of guide shafts, distributed around the axis of the support column, wherein one end of each guide shaft is connected to the support base, and the other end of each guide shaft is connected to the first support member, such that the rotation of the support base drives the first support member and the robot to rotate.

In one embodiment of the present application, the rotating mechanism further includes a rotating drive device and a connecting block. One end of the connecting block is connected to the rotating drive device, and the other end of the connecting block is connected to the support base.

In one embodiment of the present application, the connecting block is Y-shaped. A first branch of the connecting block has one end connected to the rotating drive device, the other end of the first branch is connected to one end of a second branch and one end of a third branch of the connecting block, and the other end of the second branch and the other end of the third branch are both connected to the support base.

In one embodiment of the present application, the substrate transfer apparatus further comprises a first bearing, and the first bearing is a deep groove ball bearing. The first bearing is disposed between the support base and the support column, and the support base is rotatably connected to the support column via the deep groove ball bearing serving as the first bearing.

In one embodiment of the present application, one end of each guide shaft is slidably connected to the first support member via a linear bearing, and the other end of each guide shaft is fixedly connected to the support base; or one end of each guide shaft is fixedly connected to the first support member, and the other end of each guide shaft is slidably connected to the support base via the linear bearing; or one end of each guide shaft is fixedly connected to the first support member, and the other end of each guide shaft is fixedly connected to the support base, wherein each guide shaft is a vertically telescopic structure.

In one embodiment of the present application, the lifting support members further include a second bearing and a second support member. The second bearing is arranged between the first support member and the second support member, wherein the first support member is rotatably connected to the second support member via the second bearing. The lifting drive device is configured to drive the second support member to drive the first support member and the robot to ascend and descend.

In one embodiment of the present application, the second bearing is a cross roller bearing.

In one embodiment of the present application, the substrate transfer apparatus further comprises a sealing cover and a sealing member. One end of the support column is connected to a base, and the base is provided with an accommodating cavity. The sealing cover covers the upper side of the support column, the first support member, and the second support member, and seals the accommodating cavity. The accommodating cavity is provided with a first side wall, and the sealing cover is provided with a second side wall opposite to the first side wall. The sealing member is disposed between the first side wall and the second side wall, wherein the first support member is fixedly connected to the sealing cover, and the robot is mounted on the top surface of the sealing cover.

In one embodiment of the present application, the sealing member is further included, and the sealing member includes any one or a combination of a multi-layer sealing ring, a spring-energized sealing ring, and a magnetic fluid sealing member. The multi-layer sealing ring, the spring-energized sealing ring, and the magnetic fluid sealing member are arranged between the second side wall of the sealing cover and the first side wall of the base.

In addition, the present application further provides a substrate processing apparatus, and the substrate processing apparatus comprises the substrate transfer apparatus described in any one of the above embodiments.

The plurality of guide shafts share the same mounting reference surface in the present application. This arrangement reduces the fitting tolerance requirements for perpendicularity and concentricity between the plurality of guide shafts and the support

base, and lowers the machining cost of the support base. In addition, the cross roller bearing used in the present application can eliminate or reduce bearing clearance, thereby ameliorating the tilting or jitter phenomenon of the robot and improving the running stability of the robot.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present invention are further illustrated by the following embodiments and accompanying drawings of the embodiments. The accompanying drawings are intended to provide a further understanding of the present application. The accompanying drawings are incorporated into and constitute a part of the present application to illustrate the embodiments of the present application, serving to explain the principles of the present application together with the present specification.

FIGS. 1 and 2 are top schematic diagrams illustrating a robot positioned at different working stations according to one embodiment of the present application;

FIGS. 3 to 5 are three-dimensional schematic diagrams of a substrate transfer apparatus according to one embodiment of the present application;

FIG. 6 is a front schematic diagram of a substrate transfer apparatus according to one embodiment of the present application;

FIGS. 7 and 8 are cross-sectional schematic diagrams of a substrate transfer apparatus according to one embodiment of the present application.

Reference Numerals for Drawings

Process chamber 10	Lifting drive device 134	Base 180
First working station 11	Power output shaft 134a	Accommodating cavity181
Second working station 12	First lifting block 135	First side wall 181a
Door curtain 30	Second lifting block 136	Sealing cover 190

Substrate 40	Linear guide rail 137	Second side wall 191
Substrate transfer apparatus 100	Rotating mechanism 140	Top wall 192
Support column 110	Support base 141	Groove 193
Robot 120	Rotating drive device 142	Sealing ring 210
Lifting mechanism 130	Connecting block 143	Shaft pin 220
First support member 131	Guide shaft 150	Mounting plate 230
Second bearing 132	Linear bearing 160	Fixing member 240
Second support member 133	First bearing 170	Locking member 250

PREFERRED EMBODIMENTS OF THE INVENTION

To further clarify the technical solutions of the embodiments of the present application, the accompanying drawings used for describing the embodiments are briefly introduced below. It is obvious that the accompanying drawings described below merely illustrate some examples or embodiments of the present application. Those of ordinary skill in the relevant art can apply the present application to other similar scenarios based on these accompanying drawings without making creative efforts. Unless otherwise obvious from the context or otherwise specified, identical reference numerals in the drawings represent identical structures or operations.

As used in the specification and claims of the present application, articles "a," "an," "one," and "the" do not exclusively refer to singular objects and may also cover plural objects unless the context clearly dictates otherwise. Generally, the terms "comprise" and "include" only indicate the inclusion of explicitly defined steps and components, and such steps and components do not form an exclusive enumeration, and the apparatus or method may also contain other steps or components.

Unless otherwise specifically stated, the relative arrangement of components and steps, numerical expressions, and numerical values described in the embodiments

should not limit the scope of the present application. Meanwhile, it should be understood that for the convenience of description, the dimensional proportions of each component 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 will not be described in detail, but such technologies, methods, and apparatuses should be deemed as a part of the authorized specification when appropriate. In all illustrative and discussed examples provided herein, any specific numerical value should be interpreted as merely exemplary and not limiting. Accordingly, other examples of the illustrative embodiments may adopt different numerical values. It should be noted that similar reference numerals and letters denote 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 discussed in subsequent accompanying drawings.

In the description of the present application, it should be understood that the orientation or positional relationship indicated by the directional terms such as "front, rear, upper, lower, left, right," "horizontal, vertical, perpendicular, horizontal," "top, bottom" is generally based on the orientation or positional relationship shown in the accompanying drawings, and are only used to facilitate description of the present application and simplify the description. Unless otherwise specified, such directional terms do not indicate or imply that the referred device or component must adopt a specific orientation or be constructed and operated in a specific orientation, and thus should not be construed as limiting the protection scope of the present application. Directional terms "inner, outer" refer to the inner and outer sides relative to the contour of each component itself.

For the convenience of description, spatial relative terms such as "above," "on," "on the upper surface of," "upper," and the like may be used herein to describe the spatial positional relationship between one device or feature and other devices or features as shown in the drawings. It should be understood that such spatial relative terms are intended to cover different orientations of the device during use or operation, in addition to the orientation shown in the drawings. For example, if a device in the accompanying drawing is inverted, then a device described as "above" or "on" other structures or devices will be positioned "below" or "underneath" other structures or

devices. Therefore, the illustrative term "above" covers both the orientation of "above" and "below". The device may also be positioned in other orientations (rotated by 90 degrees or in other positions), and the spatial relative description used herein should be interpreted correspondingly.

In addition, it should be clarified that the use of terms "first," "second," and the like to limit components is merely to distinguish corresponding components for convenience. Unless otherwise specified, the above terms carry no special meanings and should not be construed as limiting the protection scope of the present application. Moreover, although terms used in the present application are selected from commonly known and widely used terms, some terms mentioned in the specification of the present application may be selected according to the applicant's judgment, and the detailed meanings of the terms are explained in relevant parts of the text. In addition, the present application should be understood not only through the actual terms used, but also through the inherent meanings contained in each term.

A substrate transfer apparatus and a substrate processing apparatus of the present application are described through the following embodiments.

FIGS. 1 and 2 are top schematic diagrams illustrating a robot 120 positioned at different working stations according to one embodiment. FIG. 3 is a three-dimensional schematic diagram of a substrate transfer apparatus 100 according to one embodiment, wherein a substrate 40 is shown for ease of understanding. It should be understood that the substrate transfer apparatus 100 does not comprise a substrate. With reference to FIGS. 1 to 3, the substrate transfer apparatus 100 can be arranged inside a process chamber 10. The substrate transfer apparatus 100 can drive the robot 120 to ascend, descend, and rotate, so as to transfer the substrate 40 between a first working station 11 and a second working station 12. The process chamber 10 can be an annealing chamber, the first working station 11 can be a cold plate inside the annealing chamber, and the second working station 12 can be a hot plate inside the annealing chamber. The process chamber 10 may also be other types of chambers, such as chambers for Chemical Vapor Deposition (CVD), chambers for Physical Vapor Deposition (PVD), or chambers for substrate cleaning treatment. The process chamber 10 is provided with a door curtain 30, and the substrate 40 can enter the interior of the process chamber 10 through a substrate transfer port at the door curtain 30. A gas blowing device may be

arranged at the door curtain 30 to block external contaminants from entering the process chamber 10.

FIGS. 4 and 5 are three-dimensional schematic diagrams of a substrate transfer apparatus under different viewing angles according to one embodiment. FIG. 6 is a front schematic diagram of a substrate transfer apparatus according to one embodiment. FIGS. 7 and 8 are cross-sectional schematic diagrams of a substrate transfer apparatus according to one embodiment. Wherein, the robot 120 is not shown in FIGS. 4 and 5; FIG. 7 illustrates a state where the robot 120 is lifted, and FIG. 8 illustrates a state where the robot 120 is lowered. A base 180 is shown in FIGS. 7 and 8 for ease of understanding. It should be understood that the substrate transfer apparatus of the present application does not comprise the base 180. With reference to FIGS. 4 to 8, the substrate transfer apparatus 100 comprises a support column 110, the robot 120, a lifting mechanism 130, a rotating mechanism 140, and a plurality of guide shafts 150. The rotating mechanism 140 can drive the robot 120 to rotate, and the lifting mechanism 130 can drive the robot 120 to ascend and descend.

Specifically, the lower end of the support column 110 is fixedly connected to the base 180. The rotating mechanism 140 includes a support base 141, and the support base 141 is rotatably connected to the support column 110, that is, the support base 141 can rotate around the support column 110. In one embodiment, the rotatable connection between the support base 141 and the support column 110 is realized through the following arrangement: The substrate transfer apparatus 100 is provided with first bearings 170 disposed between the support base 141 and the support column 110. The inner circumferential surfaces of the first bearings 170 are connected to the outer circumferential surface of the support column 110, and the outer circumferential surfaces of the first bearings 170 are connected to the inner circumferential surface of the support base 141. With such an arrangement, the support base 141 can rotate around the support column 110 under external force. The first bearings 170 may be deep groove ball bearings or other types of bearings, such as cross roller bearings. Preferably, a plurality of deep groove ball bearings are arranged between the support base 141 and the support column 110 and spaced apart along a vertical direction, which ensures high concentricity between the support base 141 and the support column 110 and improves the stability of rotation when the support base 141 drives the robot 120 to rotate.

With reference to FIGS. 5 and 7, in some embodiments, the lower end of the support column 110 can be fixedly connected to the base 180 via a locking member 250. Certainly, other connection modes can also be used to fix the support column 110 and the base 180.

With reference to FIGS. 5 and 6, the rotating mechanism 140 further includes a rotating drive device 142 and a connecting block 143. The rotating drive device 142 includes, but is not limited to, a cylinder. In the embodiment shown in FIGS. 5 and 6, the connecting block 143 is Y-shaped. The Y-shaped connecting block 143 includes a first branch 143a, a second branch 143b, and a third branch, and the third branch cannot be observed in FIGS. 5 and 6 due to viewing angle limitations in FIGS. 5 and 6. One end of the first branch 143a is connected to the rotating drive device 142, and the other end of the first branch 143a is connected to one end of the second branch 143b and one end of the third branch; the other end of the second branch 143b and the other end of the third branch are both connected to the support base 141. With reference to FIG. 7, the rotating drive device 142 and the first branch 143a can be connected via a shaft pin 220. With reference to FIGS. 5 to 7, the rotating drive device 142 can push or pull the shaft pin 220 to move, the shaft pin 220 drives the connected connecting block 143 to move, and the connecting block 143 further drives the connected support base 141 to rotate around the support column 110.

It should be noted that the connecting block 143 is not limited to the Y-shaped structure in the foregoing embodiments, and other structural forms are also feasible. For example, the connecting block 143 may be linear, one end of the linear connecting block 143 is connected to the rotating drive device 142, and the other end of the linear connecting block 143 is connected to the support base 141. In short, any connecting structure that can connect the rotating drive device 142 and the support base 141 and enable the rotating drive device 142 to drive the support base 141 to rotate can be used as the connecting block 143.

With reference to FIGS. 5 to 7, the lifting mechanism 130 includes a lifting drive device 134 and lifting support members. The lifting support members include first support members 131, second bearings 132, and second support members 133. The lifting drive device 134 can drive the robot 120 to ascend and descend along the guide shafts 150 via the first support members 131, the second bearings 132, and the second

support members 133. The detailed arrangement is described below. With reference to FIG. 7, the plurality of guide shafts 150 are distributed around the axis of the support column 110. The lower end of each guide shaft 150 is fixedly connected to the support base 141, and the upper end of each guide shaft 150 is vertically slidably connected to the first support member 131 via a linear bearing 160. The linear bearing 160 is sleeved on the outer circumferential surface of the guide shaft 150 and can move vertically along the guide shaft 150. Each first support member 131 is fixedly connected to the linear bearing 160 and sleeved on the outer circumferential surface of the linear bearing 160, so the first support member 131 can move vertically up and down together with the linear bearing 160 along the guide shaft 150. The top end of each first support member 131 is fixedly connected to a sealing cover 190, and the robot 120 is mounted on the top surface of the sealing cover 190 (as shown in FIG. 3). Accordingly, vertical movement of the first support members 131 can drive the robot 120 to ascend and descend. In addition, since each first support member 131 is fixedly connected to the linear bearing 160, and both ends of each guide shaft 150 are connected to the linear bearing 160 and the support base 141, respectively, when the support base 141 drives the plurality of guide shafts 150 to rotate around the support column 110, the first support members 131 will also rotate around the support column 110 together with the guide shafts 150. It should be noted that the connection mode between the lifting mechanism 130 and the robot 120 is not limited to the foregoing embodiments. Any connecting structure that can connect the lifting mechanism 130 and the robot 120 and can be driven by the lifting mechanism 130 to drive the robot 120 to ascend and descend falls within the protection scope of the present application. Other instructions regarding the guide shafts 150 will be described in detail later and will not be elaborated here.

The second bearings 132 are disposed between the first support members 131 and the second support members 133, and the first support members 131 are rotatably connected to the second support members 133 via the second bearings 132. In other words, when the first support members 131 rotates around the support column 110 following the guide shafts 150, the first support members 131 will not drive the second support members 133 to rotate around the support column 110 synchronously due to the rotatable connection between the first support members 131 and the second support members 133 via the second bearings 132. Preferably, the second bearings 132 are

cross roller bearings. Compared with other types of bearings such as deep groove ball bearings, cross roller bearings have smaller bearing clearance (clearance between rollers and inner/outer rings), which helps ameliorate the tilting or jitter phenomenon of the robot 120 and improve the running stability of the robot 120. In FIG. 7, two second bearings 132 are adjacently arranged vertically, preferably, both second bearings 132 shown in FIG. 7 are cross roller bearings, which can further reduce bearing clearance. Certainly, the number of the second bearings 132 is not limited to two, as shown in FIG. 7, one or three second bearings 132 can also be employed.

In addition, the first support members 131, the second bearings 132, and the second support members 133 cannot move relatively in the vertical direction. In other words, vertical ascending or descending movement of any one of the three components will drive the other two components to move vertically synchronously. This synchronous movement technical effect can be realized by clamping the second bearings 132 between the first support members 131 and the second support members 133. For example, the lifting drive device 134 can drive the second support members 133 to drive the first support members 131 and the robot 120 to ascend and descend.

As described above, the rotating drive device 142 can push or pull the shaft pin 220 to move, the shaft pin 220 drives the connected connecting block 143 to move, and the connecting block 143 further drives the connected support base 141 to rotate around the support column 110. Since the plurality of guide shafts 150 are connected to the support base 141, the rotation of the support base 141 can drive the plurality of guide shafts 150 to rotate around the support column 110. The present application imposes no restriction on the number of guide shafts 150, and the number of guide shafts 150 may be three, four, five, six, or other values.

With reference to FIG. 7, the connection mode between each guide shaft 150 and the support base 141 is as follows: The support base 141 is provided with a plurality of through holes distributed around the axis of the support column 110 when viewed from the perspective of the accompanying drawings. The lower end of each guide shaft 150 is inserted into the corresponding through hole to realize the connection between the guide shaft 150 and the support base 141. The bottom surfaces of the plurality of guide shafts 150 can be flush with the bottom surface of the support base 141. In other words, the plurality of guide shafts 150 share the same horizontal mounting reference

surface, namely the bottom surface of the support base 141.

When assembling and matching the plurality of guide shafts 150 with the support base 141, two constraint relationships exist between the plurality of guide shafts 150 and the support base 141, namely, the perpendicularity constraint relationship and the concentricity constraint relationship. The perpendicularity constraint relationship requires that the plurality of guide shafts 150 be perpendicular to a horizontal plane of the support base 141, and this horizontal plane serves as the mounting reference surface of the plurality of guide shafts 150 (for example, the bottom surface of the support base 141 mentioned above can be used as the mounting reference surface). Certainly, the mounting reference surface is not limited to the bottom surface of the support base 141 and may be other horizontal planes on the support base 141. Adopting the same mounting reference surface for the plurality of guide shafts 150 reduces the fitting tolerance requirements for perpendicularity between the plurality of guide shafts 150 and the support base 141, and lowers the machining cost of the support base 141. The concentricity constraint relationship requires that the projection distances of the axes of the plurality of guide shafts 150 and the support base 141 on the horizontal plane be identical. Making the mounting reference surfaces of the plurality of guide shafts 150 the same can reduce the fitting tolerance requirements for concentricity between the plurality of guide shafts 150 and the support base 141, and also reduce the machining cost of the support base 141.

Alternative connection mode between the plurality of guide shafts 150, the first support members 131, and the support base 141 is provided as follows, which is described with reference to FIG 7. Specifically, the upper end of each guide shaft 150 is fixedly connected to the first support member 131, and the lower end of each guide shaft 150 is slidably connected to the support base 141 via the corresponding linear bearing 160. The linear bearing 160 is fixedly connected to the support base 141 and sleeved on the outer circumferential surface of the guide shaft 150, so the guide shaft 150 and the linear bearing 160 form a vertical sliding connection. Similar to the foregoing embodiments, when the plurality of linear bearings 160 are assembled with the support base 141, perpendicularity and concentricity constraint relationships exist between the plurality of linear bearings 160, the plurality of guide shafts 150, and the support base 141. Adopting the same reference surface for the plurality of linear

bearings 160 reduces the fitting tolerance requirements for perpendicularity and concentricity between the plurality of linear bearings 160, the plurality of guide shafts 150, and the support base 141, and lowers the machining cost of the support base 141.

Alternative connection mode between the plurality of guide shafts 150, the first support members 131, and the support base 141 is provided as follows. Specifically, the upper end of each guide shaft 150 is fixedly connected to the first support member 131, and the lower end of each guide shaft 150 is fixedly connected to the support base 141. Each guide shaft 150 is provided with a vertically telescopic function. When the lifting drive device 134 drives the first support members 131 to ascend and descend, the first support members 131 drive the guide shafts 150 to extend or retract.

The driving process of the rotating mechanism 140 for rotating the robot 120 around the support column 110 is explained below. Firstly, the rotating drive device 142 drives the support base 141 to rotate around the support column 110; then, the support base 141 drives the plurality of connected guide shafts 150 to rotate around the support column 110; then, the guide shafts 150 drive the connected first support members 131 to rotate around the support column 110; finally, the first support members 131 drive the sealing cover 190 to rotate, and the sealing cover 190 further drives the robot 120 mounted on the top surface of the sealing cover 190 to rotate around the support column 110. With reference to FIGS. 1 and 2, the rotating mechanism 140 can drive the robot 120 to rotate between the first working station 11 and the second working station 12 through the above movement flow.

The description of the lifting mechanism is further explained below. With reference to FIGS. 4 to 8, the lifting mechanism 130 includes the lifting drive device 134, a first lifting block 135, a second lifting block 136, and a linear guide rail 137. The lifting drive device 134 is mounted on a mounting plate 230, and the mounting plate 230 is connected to the base 180 via a fixing member 240 to realize the fixed connection between the lifting drive device 134 and the base 180. The lifting drive device 134 includes, but is not limited to, a cylinder. The linear guide rail 137 is fixedly connected to the base 180 via the fixing member 240. The first lifting block 135 is slidably connected to the linear guide rail 137 and can move vertically up and down along the linear guide rail 137. The first lifting block 135 is connected to the second lifting block 136, so the vertical movement of the first lifting block 135 along the linear

guide rail 137 can drive the second lifting block 136 to move vertically synchronously. The second lifting block 136 is fixedly connected to the second support members 133 disposed above the second lifting block 136, so the vertical movement of the second lifting block 136 can drive the connected second support members 133 to move vertically synchronously. A power output shaft 134a of the lifting drive device 134 is connected to the first lifting block 135, so the lifting drive device 134 can drive the first lifting block 135 to perform vertical ascending and descending movements.

Based on the foregoing description of the lifting mechanism, the process through which the lifting drive device 134 drives the robot 120 to ascend and descend is elaborated below. FIG. 7 illustrates a state where the robot 120 is lifted, and FIG. 8 illustrates a state where the robot 120 is lowered. The movement flow for adjusting the robot 120 from the lifted state shown in FIG. 7 to the lowered state shown in FIG. 8 includes the following steps: Firstly, with reference to FIGS. 4 and 7, the lifting drive device 134 drives the connected first lifting block 135 to move downward, and the first lifting block 135 slides downward along the linear guide rail 137; then, with reference to FIGS. 7 and 8, the downward movement of the first lifting block 135 drives the connected second lifting block 136 to move downward synchronously; then, since the second lifting block 136 is fixedly connected to the second support members 133, the downward movement of the second lifting block 136 drives the second support members 133 to move downward synchronously; finally, as described above, the first support members 131, the second bearings 132, and the second support members 133 cannot move relatively in the vertical direction, so the downward movement of the second support members 133 drives the second bearings 132 and the first support members 131 to move downward synchronously. The first support members 131 further drive the robot 120 to descend under the guiding effect of the guide shafts 150.

The foregoing movement flow describes the process through which the lifting drive device 134 drives the robot 120 to descend. The process for the lifting drive device 134 to drive the robot 120 to ascend is similar and briefly summarized as follows: Firstly, the lifting drive device 134 drives the connected first lifting block 135 to move upward, and the first lifting block 135 slides upward along the linear guide rail 137; then, the upward movement of the first lifting block 135 drives the connected second lifting block 136 to move upward synchronously; then, the upward movement

of the second lifting block 136 drives the second support members 133 to move upward synchronously; finally, the upward movement of the second support members 133 drives the second bearings 132 and the first support members 131 to move upward synchronously, and the first support members 131 further drive the robot 120 to ascend under the guiding effect of the guide shafts 150.

The process through which the substrate transfer apparatus transfers the substrate between the first working station 11 and the second working station 12 is described below for a clearer understanding of the substrate transfer apparatus of the present invention. With reference to FIGS. 1 and 2, firstly, the robot 120 returns to the initial state shown in FIG. 1, the rotating mechanism drives the robot 120 to rotate to the first working station 11, and the lifting mechanism drives the robot 120 to descend to the state shown in FIG. 8; then, an external robot transfers the substrate 40 through the transfer port at the door curtain 30 and places the substrate 40 on the first working station 11 as shown in FIG. 1; finally, the lifting mechanism drives the robot 120 to ascend, so that the robot 120 lifts the substrate 40 from the lower side of the substrate 40, the rotating mechanism drives the robot 120 to transfer the substrate 40 from the first working station 11 to a position above the second working station 12, and the lifting mechanism drives the robot 120 to descend to place the substrate 40 on the second working station 12. Therefore, the above steps realize transfer of the substrate 40 from the first working station 11 to the second working station 12.

After the processing of the substrate 40 is completed, firstly, the lifting mechanism drives the robot 120 to ascend, so that the robot 120 lifts the substrate 40 disposed on the second working station 12 from the lower side of the substrate 40, the rotating mechanism drives the robot 120 to transfer the substrate 40 from the second working station 12 to the position above the first working station 11; then, the lifting mechanism drives the robot 120 to descend to place the substrate 40 on the first working station 11, waiting for the external robot to pick the substrate. During the processes of lifting, placing, and transferring the substrate 40, the robot 120 is always positioned below the substrate 40.

With reference to FIGS. 7 and 8, in one embodiment, the sealing cover 190 covers the upper side of the support column 110, the first support members 131, and the second support members 133, and the sealing cover 190 seals an accommodating

cavity 181 described below. Specifically, the sealing cover 190 includes a second side wall 191 and a top wall 192. One end of the second side wall 191 is connected to the top wall 192, and the other end of the second side wall 191 extends downward. Accordingly, the top wall 192 is disposed above the support column 110, the first support members 131, and the second support members 133, and the second side wall 191 surrounds the support column 110, the first support members 131, and the second support members 133. Wherein, the first support members 131 are fixedly connected to the sealing cover 190 (i.e., the bottom surface of the top wall 192), and the robot 120 is mounted on the top surface of the sealing cover 190 (i.e., the top surface of the top wall 192).

In one embodiment, the substrate transfer apparatus 100 further comprises a sealing member. The detail is described as follows: The base 180 is provided with the accommodating cavity 181 for installing the substrate transfer apparatus 100, and the accommodating cavity 181 is provided with a first side wall 181a, the second side wall 191 of the sealing cover 190 is arranged opposite to the first side wall 181a of the accommodating cavity 181, and the sealing member is disposed between the first side wall 181a and the second side wall 191. In one embodiment, the sealing member includes a multi-layer sealing ring 210 disposed between the second side wall 191 of the sealing cover 190 and the first side wall 181a of the base 180. With reference to FIGS. 5 and 8, the sealing cover 190 is provided with two annular grooves 193 formed on the second side wall 191, and the opening of each groove 193 faces the first side wall 181a of the base 180. One multi-layer sealing ring 210 is shown in FIG. 8, a part of the multi-layer sealing ring 210 is embedded inside the grooves 193, and the part of the multi-layer sealing ring 210 outside the grooves 193 is in contact with the first side wall 181a of the base 180. As shown in FIGS. 7 and 8, the base 180 may internally form the process chamber 10. A gap S may be present between the second side wall 191 and the first side wall 181a, and the gap S can make the process chamber 10 and the external environment (such as atmosphere) in communication. The multi-layer sealing ring 210 can seal the gap S between the sealing cover 190 and the base 180, preventing the process chamber 10 from being in communication with the external environment through the gap S1, thereby preventing gas inside the process chamber 10 (such as hydrogen) from leaking outward through the gap S and preventing external contaminants from entering the process chamber 10 through the gap S to contaminate

the substrate.

The present application imposes no restriction on the number of grooves 193 and multi-layer sealing rings 210. For example, one or three grooves 193 are provided, and two or three multi-layer sealing rings 210 can be provided. In addition, the number of grooves 193 may be equal to or different from the number of multi-layer sealing rings 210. The multi-layer sealing ring 210 increases the sealing contact area and accordingly improves sealing performance.

Alternative sealing solutions are provided as follows: Instead of adopting the multi-layer sealing ring 210 to seal the base 180 and the sealing cover 190, a magnetic fluid sealing member or a spring-energized sealing ring can be used to realize sealing between the base 180 and the sealing cover 190. In some embodiments, a combination of the multi-layer sealing ring 210, the spring-energized sealing ring, and the magnetic fluid sealing member can be simultaneously used to seal the base 180 and the sealing cover 190.

In addition, the present application further provides a substrate processing apparatus, and the substrate processing apparatus comprises the substrate transfer apparatus described in any of the foregoing embodiments. The substrate processing apparatus may be a substrate annealing treatment apparatus, a substrate cleaning treatment apparatus, or an apparatus for depositing material layers on the substrate, etc.

The foregoing description merely illustrates basic conceptions of the present invention. It is obvious to those skilled in the art that the above disclosure is merely exemplary and should not be construed as limiting the present application. Although not explicitly elaborated herein, those skilled in the art can make various modifications, improvements, and corrections to the present application. Such modifications, improvements, and corrections suggested by the present application shall all fall within the spirit and scope of the exemplary embodiments of the present application.

Meanwhile, specific terms are used to describe the embodiments of the present application. Phrases such as "one embodiment," "an embodiment," and/or "some embodiments" refer to a specific feature, structure, or characteristic related to at least one embodiment of the present application. Accordingly, it should be emphasized and

noted that the terms "one embodiment," "an embodiment," or "an alternative embodiment" mention twice or more at different positions in the present specification does not necessarily refer to the same embodiment. In addition, certain features, structures, or characteristics of one or more embodiments of the present application can be appropriately combined.

Similarly, it should be noted that multiple features are integrated into one embodiment, accompanying drawing, or corresponding description thereof in the foregoing description of the embodiments of the present application to simplify the disclosed description and facilitate understanding of one or more embodiments of the present application. However, such a disclosure method does not mean that the subject matter of the present application requires more features than the features recited in the claims. In fact, the features of an embodiment should be fewer than all the features of the single embodiment disclosed above.

In some embodiments, numbers describing the quantity of ingredients and attributes are used. It should be understood that, in some examples, such numbers used in the description of the embodiments are modified by terms such as "about," "approximately," or "substantially." Unless otherwise specified, the terms "about," "approximately," or "substantially" indicate that the number allows for a variation of ±20%. Accordingly, in some embodiments, the numerical parameters set forth in the specification and claims are approximations that may vary depending upon the desired characteristics of individual embodiments. In some embodiments, numerical parameters shall take into account the specified significant digits and adopt the conventional digit rounding method. Although the numerical ranges and parameters used in some embodiments of the present application for confirming the breadth of the scope are approximations, in specific embodiments, such numerical values are set as precisely as practicable within the feasible range.

The present application has been described with reference to specific embodiments hereinabove. Those of ordinary skill in the relevant art should recognize that the foregoing embodiments merely serve to illustrate the present application. Various equivalent modifications or substitutions can be implemented without departing from the spirit of the present application. Accordingly, all variations and modifications made within the substantial spirit of the present application shall fall

within the scope of the claims of the present application.

What is claimed is:

1. A substrate transfer apparatus, comprising:

a support column (110);

a robot (120), configured to support a substrate (40);

a lifting mechanism (130), including a lifting drive device (134) and lifting support members, wherein the lifting drive device (134) is configured to drive the lifting support members to ascend and descend, the lifting support members include a first support member (131), and the first support member (131) is fixedly connected to the robot (120), so as to drive the robot (120) to perform ascending and descending movements;

a rotating mechanism (140), including a support base (141), wherein the rotating mechanism (140) is rotatably connected to the support column (110) via the support base (141), the rotating mechanism (140) is configured to drive the robot (120) and the first support member (131) to rotate around the support column (110);

a plurality of guide shafts (150), distributed around the axis of the support column (110), wherein one end of each guide shaft (150) is connected to the support base (141), and the other end of each guide shaft (150) is connected to the first support member (131), such that the rotation of the support base (141) drives the first support member (131) and the robot (120) to rotate.

2. The substrate transfer apparatus according to claim 1, wherein the rotating mechanism (140) further includes a rotating drive device (142) and a connecting block (143), one end of the connecting block (143) is connected to the rotating drive device (142), and the other end of the connecting block (143) is connected to the support base (141).

3. The substrate transfer apparatus according to claim 2, wherein the connecting block (143) is Y-shaped, a first branch of the connecting block (143) has one end connected to the rotating drive device (142), the other end of the first branch is connected to one end of a second branch and one end of a third branch of the connecting

block (143), and the other end of the second branch and the other end of the third branch are both connected to the support base (141).

4. The substrate transfer apparatus according to claim 1, wherein the substrate transfer apparatus further comprises a first bearing (170), the first bearing (170) is disposed between the support base (141) and the support column (110), and the support base (141) is rotatably connected to the support column (110) via the first bearing (170).

5. The substrate transfer apparatus according to claim 1, wherein one end of each guide shaft (150) is slidably connected to the first support member (131) via a linear bearing (160), and the other end of each guide shaft (150) is fixedly connected to the support base (141); or one end of each guide shaft (150) is fixedly connected to the first support member (131), and the other end of each guide shaft (150) is slidably connected to the support base (141) via a linear bearing; or one end of each guide shaft (150) is fixedly connected to the first support member (131), the other end of each guide shaft (150) is fixedly connected to the support base (141), and each guide shaft (150) is a vertically telescopic structure.

6. The substrate transfer apparatus according to claim 1, wherein the lifting support members further include a second bearing (132) and a second support member (133), the second bearing (132) is arranged between the first support member (131) and the second support member (133), the first support member (131) is rotatably connected to the second support member (133) via the second bearing (132), and the lifting drive device (134) is configured to drive the second support member (133) to drive the first support member (131) and the robot (120) to ascend and descend.

7. The substrate transfer apparatus according to claim 6, wherein the second bearing (132) is a cross roller bearing.

8. The substrate transfer apparatus according to claim 6, wherein the substrate transfer apparatus further comprises a sealing cover (190) and a sealing member, one end of the support column (110) is connected to a base (180), and the base (180) is provided with an accommodating cavity (181), the sealing cover (190) covers the upper side of the support column (110), the first support member (131), and the second support member (133), and seals the accommodating cavity (181), the accommodating

cavity (181) is provided with a first side wall (181a), the sealing cover (190) is provided with a second side wall (191) opposite to the first side wall (181a), the sealing member is disposed between the first side wall (181a) and the second side wall (191), the first support member (131) is fixedly connected to the sealing cover (190), and the robot (120) is mounted on the top surface of the sealing cover (190).

9. The substrate transfer apparatus according to claim 8, wherein the sealing member includes any one or a combination of a multi-layer sealing ring (210), a spring-energized sealing ring, and a magnetic fluid sealing member.

10. A substrate processing apparatus, comprising the substrate transfer apparatus according to any one of claims 1 to 9.