

PRE-ALIGNMENT APPARATUS AND METHOD

TECHNICAL FIELD

The present disclosure relates to the manufacturing of integrated circuits, and more particularly to a pre-alignment apparatus and a pre-alignment method.

5 BACKGROUND

During the production of semiconductor devices, the silicon wafer needs to be transferred to a workpiece station with high centering and orientational precision so as to be exposed in a fixed posture. Because the position and the orientation of the silicon wafer are not determined when the silicon wafer is placed in a silicon wafer slot, the silicon wafer needs to be pre-aligned with a certain precision before the silicon wafer is transferred to a workpiece stage. Then a current position of the silicon wafer is determined by measuring the position of a center of the silicon wafer while an orientation of the silicon wafer is determined by measuring an orientation of a notch in the silicon wafer.

With the development of the semiconductor industry, silicon wafers are coming in increasingly rich types. In order to meet the positioning requirements of multiple processed wafers such as a warping wafer or an ultra-thin wafer, Chinese Patent Publication No. CN105336654A discloses a pre-alignment apparatus adapted to multiple types of silicon wafers that can meet the positioning requirements of different types of processed wafers. This pre-alignment apparatus can be adapted to the pre-alignment of a variety of processed suction discs by arranging a ceramic suction disc and a half-moon suction disc to perform multi-point absorption positioning on the silicon wafer. In recent years, however, the emergence of large warping wafers has placed new demands on the adaptability of pre-alignment apparatuses. In order to ensure the accuracy of pre-alignment, when performing pre-alignment on the large warping wafer, it is flattening treatment needs to be performed on the warping wafer. To implement the flattening treatment on the warping wafer, the warping wafer needs to be absorbed at the edges of the warping wafer to flatten the warping wafer, so that a diameter of a distribution circle of the ceramic suction disc needs to be increased. The half-moon suction disc of the above-mentioned device is arranged around the outside of the ceramic suction disc, and if the diameter of the distribution circle of the ceramic suction disc is increased, the diameter of the distribution circle of the half-moon suction disc also needs to be increased correspondingly to avoid interference between the ceramic suction disc and the half-moon suction disc. However,

if the diameter of the distribution circle of the half-moon suction disc is increased, the diameter of the distribution circle of the half-moon suction disc would be larger than the diameter of the warping wafer, such that the half-moon suction disc would be located outside the distribution area of the warping wafer, making it unable to absorb the warping wafer. Therefore, related pre-alignment apparatuses used for silicon wafers cannot meet the pre-alignment positioning requirements for large warping wafers.

SUMMARY

The object of the present disclosure is to provide a pre-alignment apparatus and method, which is capable of performing absorption positioning and flattening processing on a large warping wafer, satisfying the pre-alignment positioning requirements of a large warping wafer, and improving the pre-alignment precision of the large warping wafer.

To achieve this object, in one aspect, the present disclosure adopts the following technical solutions.

There is provided a pre-alignment apparatus that includes a bottom plate, a lifting shaft arranged on the bottom plate, a compensation shaft, and an optical-mechanical assembly, the pre-alignment apparatus further including:

a rotating shaft assembly, including a rotating shaft and an extension rod, where the rotating shaft is disposed on the lifting shaft, and one end of the extension rod is connected to the rotating shaft;

a claw disc, connected to another end of the extension rod, where a plurality of first absorption assemblies are arranged at intervals along a circumference of the claw disk; and

an annular suction disc, which is connected to the compensation shaft, and is provided with a plurality of second absorption assemblies, where the diameter of the annular suction disc is smaller than that of a distribution circle of the claw disk, the annular suction disc is sleeved outside the rotating shaft assembly, and there is formed a gap between the annular suction disc and the rotating shaft assembly;

the rotating shaft assembly is operative to drive the claw disk to rotate, the lifting shaft is operative to drive the claw disk to perform an ascending or descending motion in a vertical

direction, the compensation shaft is operative to drive the annular suction disc to move in a horizontal direction, the claw disk is provided with a handover gap configured for the second absorption assembly to pass through when transferring a silicon wafer between the claw disk and the annular suction disc.

5 In one embodiment, the first absorption assembly and/or the second absorption assembly each include a rigid strut and a rubber suction disc. The rigid strut is provided with a first vent hole, the rubber suction disc is connected to the rigid strut and is in communication with the first vent hole.

10 In one embodiment, the first absorption assembly and/or the second absorption assembly each include a rigid strut, an elastic member, an elastic strut, and a rubber suction disc. The elastic member is arranged inside the rigid strut. The elastic strut is provided with a second vent hole. One end of the elastic strut is arranged inside the rigid strut and is sleeved by the elastic member, and another end of the elastic strut is arranged outside the rigid strut and is connected to the rubber suction disc, and the rubber suction disc is in communication with the second vent
15 hole.

 In one embodiment, the claw disc is further provided with a third absorption assembly. A center of the third absorption assembly, a center of the corresponding first absorption assembly, and a center of the claw disk are collinear, and the third absorption assembly is disposed between the corresponding first absorption assembly and the center of the claw disc.

20 In one embodiment, the third absorption assembly includes a rigid strut and a rubber suction disc. The rigid strut is provided with a first vent hole, and the rubber suction disc is connected to the rigid strut and is in communication with the first vent hole.

 In one embodiment, the third absorption assembly includes a rigid strut, an elastic member, an elastic strut, and a rubber suction disc. The elastic member is arranged inside the rigid strut.
25 The elastic strut is provided with a second vent hole. One end of the elastic strut is arranged inside the rigid strut and is sleeved by the elastic member, and another end of the elastic strut is arranged outside the rigid strut and is connected to the rubber suction disc, and the rubber suction disc is in communication with the second vent hole.

 In one embodiment, the pre-alignment apparatus further includes a position adjustment
30 assembly including a slide rail, a slide block and a driving member. The slide rail is connected

to the bottom plate. The slide block is operative to slide on the slide rail, the optical-mechanical assembly is mounted on the slide block, and the drive member is connected to the slide block.

5 In one embodiment, the pre-alignment apparatus further includes a air slip ring, which is sleeved on an inner side of the extension rod and is in communication with each of the first absorption assembly and the third absorption assembly.

10 In one embodiment, the pre-alignment apparatus further includes a sensor and a blocking piece. The sensor is arranged on the annular suction disc or the second absorption assembly, and the blocking piece is arranged on the claw disk; or the sensor is arranged on the claw disk, and the blocking piece is arranged on the annular suction disc or the second absorption assembly; when the first absorption assemblies overlap with the second absorption assemblies in a radial direction, the blocking piece is operative to trigger the sensor.

15 In one embodiment, the claw disk includes at least a plurality of claw rods outwardly divergently distributed from the center of the claw disc, and the handover gap is defined between adjacent claw rods, and the corresponding first absorption assembly is arranged at an end of the claw rod.

In one embodiment, a reinforcing rib is arranged between adjacent claw rods.

In one embodiment, a rigid support block is provided at the center of the claw disk.

20 In one embodiment, when transferring the silicon wafer between the claw disk and the annular suction disc, the first absorption assemblies overlaps with the second absorption assemblies in the radial direction, the rotating shaft is operative to drive the claw disk to rotate by a predetermined angle to stagger the first absorption assemblies and the second absorption assemblies in position, where the predetermined angle is less than a third of an angle between two adjacent first absorption assemblies.

25 In another aspect, the present disclosure further provides a pre-alignment method based on any one of the above-mentioned pre-alignment apparatus, the pre-alignment method including the operations described below:

the claw disc receiving the silicon wafer;

the rotating shaft driving the claw disc to rotate, and the optical-mechanical assembly

capturing edge information of the silicon wafer and sending the captured edge information of the silicon wafer to a controller;

5 the controller calculating an eccentricity of the silicon wafer based on the received edge information of the silicon wafer, controlling rotation of the rotating shaft according to the eccentricity, and rotating a direction of the silicon wafer having a maximum eccentricity in line with a moving direction of the compensation shaft;

the lifting shaft descending to a handover position, and the claw disc transferring the silicon wafer to the annular suction disc;

10 the lifting shaft driving the claw disc to continue to descend to a handover lower position, and the compensation shaft driving the annular suction disc into motion to compensate for the eccentricity of the silicon wafer;

the lifting shaft driving the claw disc to ascend to the handover position, and the annular suction disc transferring the silicon wafer to the claw disc;

15 the lifting shaft driving the claw disc to continue to ascend to a pre-alignment position, the rotating shaft driving the claw disc to rotate, and the optical-mechanical assembly capturing notch information of the silicon wafer and the edge information of the silicon wafer, and sending the captured notch information and edge information of the silicon wafer to the controller;

20 the controller calculating an eccentricity tolerance of the silicon wafer based on the notch information and the edge information of the silicon wafer, and when the eccentricity tolerance of the silicon wafer satisfies a preset condition, the rotating shaft rotating to rotate the notch of the silicon wafer to a position under the optical-mechanical assembly; and

25 the rotating shaft rotating back and forth in small angles, the optical-mechanical assembly capturing and sending the notch information of the silicon wafer to the controller, the controller calculating a notch position error of the silicon wafer based on the notch information of the silicon wafer, and the rotating shaft rotating to compensate for the notch position error thus completing orientation of the silicon wafer.

In one embodiment, the pre-alignment method further includes the following operation

prior to the operation of the lifting shaft ascending to the handover position and the claw disk transferring the silicon wafer to the annular suction disk: driving, by the rotating shaft, the claw disk to rotate by the predetermined angle to stagger the first absorption assemblies and the second absorption assemblies in position when the first absorption assemblies overlap with the second absorption assemblies in the radial direction;

the pre-alignment method further includes the following operation subsequent to the operation of the lifting shaft driving the claw disk to continue to descend to the handover lower position: the rotating shaft driving the claw disk to continue rotating in the same direction by the predetermined angle;

the pre-alignment method further includes the following operation subsequent to the operation of the lifting shaft driving the claw disk to ascend to the handover position, and the annular suction disk transferring the silicon wafer to the claw disk: the rotating shaft driving the claw disk to rotate in a reverse direction by the predetermined angle.

In one embodiment, the predetermined angle is less than a third of an angle between two adjacent first absorption assemblies.

In one embodiment, the operation of the claw disk receiving the silicon wafer includes a wafer fork placing the silicon wafer on the claw disk, and the first absorption assemblies creating a vacuum to absorb the silicon wafer.

In one embodiment, the operation of the claw disk receiving the silicon wafer includes:

the lifting shaft driving the claw disk to descend to a wafer-mounted position, the wafer fork placing the silicon wafer on the annular suction disk, and the second absorption assemblies creating a vacuum to absorb the silicon wafer;

the lifting shaft driving the claw disk to ascend to the handover position, the first absorption assemblies creating a vacuum to absorb the silicon wafer; the second absorption assembly turning off the vacuum, and the lifting shaft driving the claw disk to ascend to the pre-alignment position.

In one embodiment, the pre-alignment method further includes the following operation prior to the operation of the claw disk receiving the silicon wafer: adjusting the position

adjustment assembly according to a size of the silicon wafer, to adjust the optical-mechanical assembly to a position corresponding to the size of the silicon wafer.

The above-mentioned pre-alignment apparatus includes a claw disc and an annular suction disc. The diameter of the annular suction disc is smaller than that of the distribution circle of the claw disc. The rotating shaft is provided with an extension rod connected to the claw disc. The annular suction disc is sleeved outside the rotating shaft assembly, and there is formed a gap between the annular suction disc and the rotating shaft assembly. The diameter of the distribution circle of the claw disc is greater than that of the annular suction disc, and the first absorption assemblies arranged on the claw disc may absorb a large warping wafer at an edge of the large warping wafer, so as to flatten the large warping wafer to realize the flattening of the large warping wafer. At the same time, when transferring the silicon wafer between the claw disc and the annular suction disc, the claw disc descends in the vertical direction, the first absorption assemblies and the second absorption assemblies are staggered from each other in position, where each of the second absorption assemblies is positioned in the handover gap between two adjacent first absorption assemblies, and the first absorption assemblies and the second absorption assemblies do not interfere with each other. In addition, there is formed a gap between the annular suction disc and the rotating shaft assembly to provide a space for a horizontal motion of the annular suction disc, which does not interfere with the rotating shaft assembly when horizontally moving along with the compensation shaft. Therefore, compared to the related pre-alignment apparatuses used for silicon wafers, the above-mentioned pre-alignment apparatus is capable of performing absorption positioning and flattening on a large warping wafer, satisfying the pre-alignment positioning requirements of the large warping wafer, and improving the pre-alignment precision of the large warping wafer.

The pre-alignment method based on the pre-alignment apparatus can perform absorption positioning and flattening on a large warping wafer, and improve the pre-alignment precision of the large warping wafer.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic view illustrating the structure of a pre-alignment apparatus according to an embodiment of the present disclosure.

FIG. 2 is a cross-sectional view illustrating a structure of a connection between a first absorption assembly and the air duct joint according to an embodiment of the present disclosure.

5 FIG. 3 is a schematic view illustrating a structure of a pre-alignment apparatus according to another embodiment of the present disclosure.

FIG. 4 is a cross-sectional view illustrating a structure of a first absorption assembly according to another embodiment of the present disclosure.

FIG. 5 is a schematic view illustrating a structure of a pre-alignment apparatus according to another embodiment

10 FIG. 6 is a flow diagram illustrating a method of a pre-alignment apparatus according to an embodiment of the present disclosure.

Description of reference numerals:

10-Bottom plate, 20-Lifting shaft, 30-Compensation shaft, 40-Optical-mechanical assembly, 50-Rotating shaft assembly, 60-Claw disc, 70-Annular suction disc, 80-Position
15 adjustment assembly, 200-Sensor, 300-Blocking piece;

41-Optical-mechanical support base, 42-First light source, 43-Lens, 44-CCD camera, 45-Second light source, 51-Rotating shaft, 52-Extension rod, 61-Claw rod, 62-First absorption assembly, 63-Air duct joint, 64-Rigid support block, 65-Third absorption assembly, 66-Reinforcing rib, 71-Second absorption assembly, 81-Slide rail, 82- Slide block, 83-Drive
20 member;

621-Rigid strut, 622-Elastic member, 623-Elastic strut, 624-Rubber suction disc, 625-Second vent hole, 626-First vent hole.

DETAILED DESCRIPTION

25 The technical solutions of the present disclosure will be further described below through specific embodiments in conjunction with the accompanying drawings.

As used herein, terms including “above”, “below”, “front”, “behind”, “left”, “right”, “vertical”, “horizontal”, “top”, “bottom”, “inside”, “outside”, and the like are used to illustrate the orientational or positional relationships based on those illustrated in the drawings, and are used for the mere purpose of facilitating and simplifying the description of the present disclosure. Therefore, these relationships do not indicate or imply that the device or component referred to has a specific orientation and is constructed and operated in a specific orientation, and so it is not to be construed as limiting the present disclosure.

As illustrated in FIG.1, a pre-alignment apparatus according to an embodiment includes a bottom plate 10, a lifting shaft 20 arranged on the bottom plate 10, a compensation shaft 30, and an optical-mechanical assembly 40, and further includes a rotating shaft assembly 50, a claw disc 60, and an annular suction disc 70. The rotating shaft assembly 50 includes a rotating shaft 51 and an extension rod 52, where the rotating shaft 51 is arranged on the lifting shaft 20, and one end of the extension rod 52 is connected to the rotating shaft 51. A claw disc 60 is connected to another end of the extension rod 52, and a plurality of first absorption assemblies 62 are arranged at intervals along a circumference of the claw disk 60. The annular suction disc 70 is connected to the compensation shaft 30, and a plurality of second absorption assemblies 71 are arranged on the annular suction disc 70. The annular suction disc 70 has a diameter smaller than that of a distribution circle of the claw disk 60, and is sleeved around the rotating shaft assembly 50, and there is formed a gap between the annular suction disc 70 and the rotating shaft assembly 50.

The rotating shaft assembly 50 is operative to drive the claw disk 60 to rotate. The lifting shaft 20 is operative to drive the claw disk 60 to perform an ascending or descending motion in a vertical direction. The compensation shaft 30 is operative to drive the annular suction disc 70 to move in a horizontal direction. The claw disk 60 is provided with a handover gap configured for the second absorption assembly 71 to pass through when transferring a silicon wafer between the claw disk 60 and the annular suction disc 71.

In particular, the optical-mechanical assembly 40 is disposed adjacent to the lifting shaft 10 for capturing edge information and notch information of a large warping silicon wafer during the motion of the claw disk 60 and the annular suction disc 70 and further transmitting the captured information to a controller. The controller is configured to calculate a center and orientation of the large warping silicon wafer based on the edge information and notch information of the large warping silicon wafer. The controller may specifically be a control

module integrated in a controller of a lithography machine, or may be a controller that is disposed independent from the pre-alignment apparatus; however, it will not be specifically limited in the present embodiment.

As illustrated in FIG. 1, the optical-mechanical assembly 40 includes a optical-mechanical support base 41, a first light source 42, a lens 43, a CCD camera 44, and a second light source 45. The optical-mechanical support base 41 is mounted on the base plate 10. The CCD camera 44 is mounted on the optical-mechanical support base 41. The first light source 41 and the lens 43 are both mounted on the CCD camera 44, and the second light source 45 is mounted on the optical-mechanical support base 41. The CCD camera 44 is configured to capture an image of the large warping silicon wafer through the lens 43, and obtain and transmit the edge information and the notch information of the large warping silicon wafer to the controller.

The above-mentioned pre-alignment apparatus includes a claw disc 60 and an annular suction disc 70. The diameter of the annular suction disc 70 is smaller than that of the distribution circle of the claw disk 60. The rotating shaft 51 is provided with the extension rod 52 connected to the claw disc 60. The annular suction disc 70 is sleeved outside the rotating shaft assembly 50, and there is formed a gap between the annular suction disc 70 and the rotating shaft assembly 50. The diameter of the distribution circle of the claw disk 60 is greater than that of the annular suction disc 70, and the first absorption assemblies 62 arranged on the claw disk 60 may absorb the large warping wafer at an edge of the large warping wafer, so as to flatten the large warping wafer realizing the flattening of the large warping wafer. At the same time, when transferring the silicon wafer between the claw disc 60 and the annular suction disc 70, the claw disc 60 descends in the vertical direction, the first absorption assemblies 62 and the second absorption assemblies 71 are staggered from each other, such that each of the second absorption assemblies 71 is positioned in the handover gap between the two adjacent first absorption assemblies 62, and the first absorption assemblies 62 and the second absorption assemblies 71 do not interfere with each other. In addition, there is formed a gap between the annular suction disc 70 and the rotating shaft assembly 50 to provide a space for a horizontal motion of the annular suction disc 70, which does not interfere with the rotating shaft 52 assembly when horizontally moving along with the compensation shaft. Therefore, compared to the related pre-alignment apparatuses used for silicon wafers, the above-mentioned pre-alignment apparatus is capable of performing absorption positioning and flattening on the large warping wafer, satisfying the pre-alignment positioning requirements of a large warping wafer, and improving the pre-alignment precision of the large warping wafer.

In one embodiment, the claw disk 60 includes at least a plurality of claw rods 61 outwardly divergently distributed from the center of the claw disc, the handover gap is defined between adjacent claw rods 61, and each of the first absorption assemblies 62 is arranged at an end of the corresponding claw rod 61. In particular, as illustrated in FIG.1, the claw disk 60 includes a plurality of claw rods 61 outwardly divergently distributed from the center of the claw disc and are arranged at same intervals along a circumference, where the handover gap is defined between adjacent claw rods 61, and each the first absorption assemblies 62 is arranged at an end of the corresponding claw rod 61. When transferring the silicon wafer between the claw disc 60 and the annular suction disc 70, the corresponding claw rod 61 and the second absorption assembly 71 are staggered from each other to drive the first absorption assemblies 62 and the second absorption assemblies 71 to stagger from each other, so that each of the second absorption assemblies 71 may pass through the corresponding handover gap. In this embodiment, the claw disk 60 includes a plurality of claw rods 61 that is arranged at intervals to form the handover gap between the adjacent claw rods 61. In other embodiments, a through hole through which the second absorption assembly 71 may pass may be defined between the adjacent first absorption assemblies 62 on the claw disc 60 as the handover gap, which is however not specifically limited in this embodiment.

As illustrated in FIG.2, in one embodiment, the first absorption assemblies 62 each include a rigid strut 621, an elastic member 622, an elastic strut 623, and a rubber suction disc 624. The elastic member 622 is arranged inside the rigid strut 621. The elastic strut 623 is provided with a second vent hole 625. One end of the elastic strut 623 is arranged inside the rigid strut 621 and is sleeved by the elastic member 622, and another end of the elastic strut 623 is arranged outside the rigid strut 621 and is connected to the rubber suction disc 624, and the rubber suction disc 624 is in communication with the second vent hole 625. Further, the second vent hole 625 is connected to the air source through the air duct joint 63. In this embodiment, the rubber suction disc 624 is connected to the rigid strut 621 via the elastic strut 623, and the elastic member 622 is arranged between the elastic strut 623 and the rigid strut 621. The elastic member 622 is formed as an elastic strut 623, and the rubber suction disc 624 is used for adapting to the amount of warpage of the warping wafer in the absorption region corresponding to the rigid strut 621, and the elastic member 622 supports an elastic motion amount of the elastic strut 623 to adapt to the amount of the warpage of the warping wafer between the plurality of first absorption assemblies 62, thereby effectively improving the absorption precision and the flattening precision of the first absorption assembly 62. In particular, in this embodiment, the elastic member 622 is implemented as a spring. In other embodiments, the elastic member 622

may also be implemented as other elastic components, which however is not specifically limited in this embodiment.

In particular, the second absorption component 71 and the first absorption component 62 differ only in size. A height of the second absorption assembly 71 is greater than that of the first absorption assembly 62, and the specific structural composition and principle thereof are the same as those of the first absorption assembly 62 and will not be detailed herein. When a height difference between the specific second absorption assembly 71 and the first absorption assembly 62 is such that the absorption surface of the first absorption assembly 62 is coplanar with that of the second absorption assembly 71 when performing a transfer between the claw disc 60 and the annular suction disc 70. Furthermore, when the height of the second absorption assembly 71 can enable the completion of the transfer between the claw disc 60 and the annular suction disc 70, the claw disc continues to move downward, the absorption surface of the second absorption assembly 71 is higher than that of the first absorption assembly 62, and the height difference between the specific second absorption assembly 71 and the first absorption assembly 62 is not specifically limited in the present embodiment.

As illustrated in FIG.3 and FIG.4, in another embodiment, the first absorption assemblies 62 each include a rigid strut 621 and a rubber suction disc 624. The rigid strut 621 is provided with a first vent hole 626, and the rubber suction disc 624 is connected to the rigid strut 621 and is in communication with the first vent hole 626. Further, the first vent hole 626 is connected to the air source via an air guiding component such as the air duct joint. In particular, the only difference between the second absorption component 71 and the first absorption component 62 lies in size, and the specific structural composition and principle thereof are the same as those of the first absorption assembly 62 and will not be described herein. The first absorption assembly 62 of the present embodiment vacuum-absorbs the warping wafer by adapting to the amount of warpage of the warping wafer, thereby realizing the absorption positioning and flattening of the warping wafer. Since the elastic member 622 and the elastic strut 623 are omitted, the first absorption assembly 62 and the second absorption assembly 71 in the present embodiment are advantageous for saving cost for the device. Specifically, in practical applications, a suitable first absorption assembly 62 and a second absorption assembly 71 may be selected according to specific processing requirements and cost requirements. Furthermore, the first absorption assembly 62 and the second absorption assembly 71 may have the same structure or different structures, and the above-mentioned embodiments are not specifically limited.

In an embodiment, the pre-alignment apparatus further includes a sensor 200 and a blocking piece 300, where the sensor 200 is arranged on the annular suction disc 70 or the second absorption assembly 71, and the blocking piece 300 is arranged on the claw disk 60; or the sensor 200 is arranged on the claw disk 60, and the blocking piece 300 is arranged on the annular suction disc 70 or the second absorption assembly 71. When the first absorption assemblies 62 overlap with the second absorption assemblies 71 in a radial direction, the blocking piece 300 is operative to trigger the sensor 200. In particular, as illustrated in FIG. 1 and FIG. 3, the claw disk 60 is provided with six claw rods 61, the annular suction disc 70 is provided with three second absorption assemblies 71. Correspondingly, the number of the sensors 200 is three, and the number of the blocking piece 300 is six. The three sensors 200 each are arranged on the corresponding second absorption assembly 71, and the six blocking pieces 300 are correspondingly arranged on the six claw rods 61. When the claw rod 61 and the second absorption assembly 71 overlap in position (that is, the first absorption assembly 62 and the second absorption assembly 71 overlap in the radial direction), the blocking piece 300 triggers the sensor 200. At this moment, there is formed a positional interference between the claw rod 61 and the second absorption assembly 71, such that the claw disk 60 cannot directly descend. At this moment, the rotating shaft 52 needs to be rotated to drive the claw disk 60 to rotate so that the claw disk 60 rotates at a certain angle to stagger from the second absorption assembly 71 in position, and then the claw disk 60 is driven to descend by the lifting shaft 20. In the above-mentioned embodiment, the sensor 200 is arranged on the second absorption assembly 71, and the blocking piece 300 is arranged on the claw disk 61. In other embodiments, the sensor 200 may also be arranged on the annular suction disc 70, or the blocking piece 300 may further be arranged on the annular suction disc 70 or the second absorption assembly, as long as the blocking piece 300 may trigger the sensor 200 when the first absorption assemblies 62 and the second absorption assemblies 71 overlap in the radial direction. The specification positions of arrangement of the sensor 200 and the blocking piece 300 however are not limited in this embodiment.

Further, in an embodiment, when transferring the silicon wafer between the claw disk 60 and the annular suction disc 70, the first absorption assemblies 62 overlap with the second absorption assembly 71 in the radial direction, the rotating shaft is operative to drive the claw disk to rotate by a predetermined angle to stagger the first absorption assemblies and the second absorption assemblies in position, where the predetermined angle is less than a third of an angle between two adjacent first absorption assemblies. In particular, when it is necessary to transfer the warping wafer on the claw disk 60 to the annular suction disc 70, the lifting shaft 20 drives

the claw disk 60 to descend in the vertical direction. If the first absorption assemblies 62 and the second absorption assemblies 71 overlap in position, that is, the corresponding claw rod 61 and the second absorption assembly 71 overlap in position, the claw disk 60 is first rotated to stagger the claw rod 61 and the second absorption assembly 71 in position. However, since the claw disk 60 is rotated before descending, the claw disk 60 is rotated together with the warping wafer, which causes the warping wafer to rotate at a certain angle relative to the original detecting position, and when the warping wafer is transferred back to the claw disk 60 by the annular suction disc 70 and ascends again to continue the detection, it is necessary to ensure that the warping wafer maintains an original detection orientation, so that a rotation compensation is required, and if the rotation compensation is directly performed, the claw rod 61 and the second absorption assembly 71 would overlap in position to interfere with the ascending of the claw disk 60. In order to prevent the claw disk 60 from interfering during the ascending, after the claw disk 60 descending and transferring the warping wafer to the annular suction disc 70, the claw disk 60 is kept rotated in the same direction at the same angle as before performing the descending, and after the warping wafer is transferred back to the claw disk 60 by the annular suction disc 70, the claw disk 60 is rotated backward by the same angle to ensure that the warping wafer return to the original detecting position. Therefore, in the present embodiment, the predetermined angle is set to be less than a third of the angle formed between the two adjacent first absorption assemblies 62, that is, a third of the angle formed between the two adjacent claw rods 61, so as to ensure that the claw disk 60 rotates in the same direction twice without interfering with the second absorption assembly 71.

In one embodiment, as illustrated in FIG. 1 and FIG. 3, a rigid support block 64 is provided at the center of the claw disk 60. In particular, an upper surface of the rigid support block 64 is coplanar with that of the rigid strut 621 of the first absorption assembly 62. The rigid support block 64 is arranged at the center of the claw disk 60, the six claw rods 61 are centered at the center of the claw disk 60 and are arranged at the same intervals along the circumference, the six first absorption assemblies 62 each are arranged at the end of the corresponding six claw rod 61, and the upper surface of the rigid support block 64 is coplanar with that of the rigid struts 621 of each of the first absorption assemblies 62. When the six first absorption assemblies 62 absorb the edges of the warping wafer and pull the edges of the warping wafer to flatten the warping wafer, the rigid support block 64 provides coplanar support at the center of the warping wafer, which can further improve the flattening precision of the warping wafer.

In the above-mentioned embodiment, the claw disk 60 is provided with six claw rods 61,

and accordingly, the number of the first absorption assembly 62 is six. However, the present embodiment is not used to specifically limit the number of the claw rod 61 and the first absorption assembly 62. In practical applications, the number of the claw rod 61 and the first absorption assembly 62 may be set according to actual needs, as long as the number of the two is ensured to be equal, more than six, or fewer than six. Similarly, in the present embodiment, the number of the second absorption assemblies 71 is three. In actual applications, the number of the second absorption assemblies 71 may be correspondingly set according to the number of the claws rods 61. Further, in order to ensure the absorption positioning and the flattening effects, the number of the claw rod 61 and the second absorption assembly 71 is typically not fewer than three.

As illustrated in FIG. 5, in another embodiment, the claw rod 61 is further provided with multiple third absorption assemblies 65, which are arranged at intervals with the corresponding first absorption assemblies 62. In the present embodiment, the claw rod 61 is provided with two sets of absorption assemblies, and the third absorption assembly 65 and the first absorption assembly 63 may perform two-stage flattening on the warping wafer, which is advantageous for improving the flattening precision of the warping wafer. Moreover, the two sets of absorption assemblies may also be used to absorb and flatten warping wafers of different sizes, which may improve the versatility of the pre-alignment apparatus. For example, the first absorption assemblies 62 may be used to absorb and flatten a warping wafer having a large size (such as a 12-inch warping silicon wafer), and the third absorption assemblies 65 may be used to absorb and flatten warping wafer having a small size (such as an 8-inch warping silicon wafer). When the 12-inch warping silicon wafer is absorbed, the third absorption assemblies 65 first create a vacuum for absorption, and then the first absorption assemblies 62 create a vacuum again for absorption, thereby achieving two-stage echelon absorption for the silicon wafer and improving the flattening precision.

As illustrated in FIG.5, in one of the embodiments, the pre-alignment apparatus further includes a position adjustment assembly 80 including a slide rail 81, a slide block 82, and a driving member 83. The slide rail 81 is connected to the bottom plate 10, the slide block 82 slides on the slide rail 81, the slide block 82 is mounted with the optical-mechanical assembly 40, and the drive member 83 is connected to the slide block 82. In this embodiment, the optical-mechanical assembly 40 is mounted on the position adjustment assembly 80, the position of the optical-mechanical assembly 40 may be adjusted by adjusting the position adjustment assembly 80 to correspond the position of optical-mechanical assembly 40 with

different warping wafers having different sizes. In particular, when it is needed to adjust the position of the optical-mechanical assembly 40, the drive member 83 is started to drive the slide block 82 to slide on the slide rail 81, thereby driving the optical-mechanical assembly 40 into motion. When the optical-mechanical assembly 40 moves to a target position, the drive member 83 is closed to stop the slide block 82 from sliding. In particular, the drive member 83 includes a drive component and a transmission mechanism. The drive component is connected to the slide block 82 via the transmission mechanism, the drive component may be any one of a motor, a pneumatic cylinder or a hydraulic cylinder, and the transmission mechanism may be a gear transmission mechanism, a screw driver mechanism, etc., which is not specifically limited in the present embodiment.

As illustrated in FIG.5, in one embodiment, the pre-alignment apparatus further includes a air slip ring (not shown in the figure), which is sleeved on an inner side of the extension rod and is in communication with each of the first absorption assembly 62 and the third absorption assembly 65. In the present embodiment, the air supply duct is provided for sole air supply for the first absorption assembly 62 and the third absorption assembly 65 by the air slip ring. In particular, the air slip ring may be a two-in and two-out air slip ring.

In one embodiment, the reinforcing rib 66 is arranged between adjacent claw rods 61. In this embodiment, arranging the reinforcing rib 66 between adjacent claw rods 61 may improve structural strength of the claw disc 60. As illustrated in FIG. 5, in the present embodiment, the reinforcing rib 66 is connected to an end of the claw rod 61. In other embodiments, the reinforcing rib 66 may be connected to any position of the claw rod 61 as long as the reinforcing rib and the second absorbing assembly 71 are ensured to not interfere with each other.

Further, as illustrated in FIG. 5, in this embodiment, the number of the sensors 200 is one, and the number of the blocking piece 300 is six. The sensor 200 is arranged on the annular suction disc 700 and is disposed to stagger from the second absorption assembly 71, the blocking piece 300 is disposed on the reinforcing rib and is disposed to stagger from the first absorbing assembly 62, and as long as one of the blocking piece 300 triggers the sensor 200, it indicates that the claw rod 61 and the second absorbing assembly 71 overlap in the radial direction. In the present embodiment, merely one sensor 200 is provided to realize interference detection between the claw rod 61 and the second absorption assembly 71, which can effectively save the sensor cost.

In one embodiment, the third absorption assemblies 65 each include a rigid strut and a rubber suction disc. The rigid strut is provided with a first vent hole. The rubber suction disc is connected to the rigid strut and is in communication with the vent hole. In another embodiment, the third absorption assemblies 65 each include a rigid strut, an elastic member, an elastic strut, and a rubber suction disc. The elastic member is arranged inside the rigid strut. The elastic strut is provided with a second vent hole. One end of the elastic strut is arranged inside the rigid strut and is sleeved by the elastic member, and another end of the elastic strut is arranged outside the rigid strut and is connected to the rubber suction disc, and the rubber suction disc is in communication with the second vent hole. In particular, the structural composition and structural principle of the third absorption assembly 65 are the same as those of the first absorption assembly 62 in the foregoing embodiments, and details are not described herein again. Furthermore, in practical applications, the first absorption assembly 62, the second absorption assembly 71, and the third absorption assembly 65 may have the same structure or different structures.

As illustrated in FIG.6, there is further provided a pre-alignment method based on the above-mentioned pre-alignment apparatus, the pre-alignment method including the following operations.

In step S11, the claw disc 60 receives a silicon wafer.

In one embodiment, when the height of the first absorption assembly 62 on the claw disk 60 is able to provide a space required for a wafer fork to take and place the silicon wafer, the silicon wafer can be directly placed on the claw disk 60. In particular, the steps S11 includes: the wafer fork places the silicon wafer on the claw disk 60, the first absorption assembly 62 creates the vacuum to absorb the silicon wafer. If the silicon wafer is the warping wafer, the first absorption assembly 62 absorbs and flattens the silicon wafer.

In one embodiment, when the height of the first absorption assembly 62 on the claw disk 60 is not able to provide the space required for the wafer fork to take and place the silicon wafer, the silicon wafer is first received via the annular suction disc 70, and then is transferred onto the claw disk 60. In particular, the step of receiving the silicon wafer by the claw disk in step S11 includes that the lifting shaft 20 drives the claw disk 60 descend to the upper wafer position, the wafer fork places the silicon wafer on the annular suction disc 70, and the second absorption assemblies 71 create a vacuum to absorb the silicon wafer; the lifting shaft 20 drives the claw

disk 60 to the transfer position, the first absorption assemblies 62 create a vacuum to absorb the silicon wafer, if the silicon wafer is the warping wafer, the first absorption assemblies 62 absorb and flatten the silicon wafer, then the second absorption assemblies 71 turn off the vacuum, and the lifting shaft 29 drives the claw disk 60 to ascend to the pre-alignment position.

5 The above-mentioned upper wafer working position may be a distance from a top surface of the rubber suction disc 624 on the first absorption assemblies 62 to a top supporting surface of the rigid support 61 of the second absorption assemblies 71, which can provide the motion space required for the wafer fork to take and place the silicon wafer.

10 The above-mentioned transfer position is coplanar with the top supporting surface of the rigid strut 621 of the first absorption assemblies 62 and the top supporting surface of the rigid strut 621 of the second absorption assemblies 71.

15 The pre-alignment position is a distance that the top surface of the rubber suction disc 624 of the second absorption assemblies 71 lower than a lower surface of the claw disk 60, and the distance is a safe space in the vertical direction between the rubber suction disc 624 and the claw disk 60 on the second absorption assemblies 71.

In step S12, the rotating shaft 52 drives the claw disc 60 to rotate, and the optical-mechanical assembly 40 captures the edge information of the silicon wafer and sends the captured edge information of the silicon wafer to the controller.

20 In step S 13, the controller calculates an eccentricity of the silicon wafer based on the received edge information of the silicon wafer, controls rotation of the rotating shaft 50 according to the eccentricity, and rotates a direction of the silicon wafer having a maximum eccentricity in line with a moving direction of the compensation shaft 30.

25 In step S14, the lifting shaft 20 drives the claw disc 60 to descend to the handover position, and the claw disc 60 transfers the silicon wafer to the annular suction disc 70; specifically, after the lifting shaft 20 drives the claw disc 60 to descend to the handover position, the second absorption assemblies 71 create the vacuum, the first absorption assemblies 62 turn off the vacuum, and the claw disc 60 transfers the silicon wafer to the annular suction disc 70.

In step S15, the lifting shaft 20 drives the claw disc 60 to continue to descend to a handover lower position, and the compensation shaft 30 drives the annular suction disc 70 into

motion to compensate for the eccentricity of the silicon wafer;

Specifically, the handover lower position is a distance from the top surface of the rubber suction disc 624 on the first absorption assemblies 62 to the lower surface of the annular suction disc 70, and the distance is the safe space in the vertical direction between the rubber suction disc 624 and the annular suction disc 70 on the first absorption assemblies 62.

In step S16, the lifting shaft 20 drives the claw disc 60 to ascend to the handover position, and the annular suction disc 70 transfers the silicon wafer to the claw disc 60; specifically, after the lifting shaft 20 drives the claw disc 60 to ascend to the handover position, the first absorption assemblies 62 create the vacuum, the second absorption assemblies 70 turn off the vacuum, and the annular suction disc 70 transfers the silicon wafer to the claw disc 60.

In step S117, the lifting shaft 20 drives the claw disc 60 to continue to ascend to a pre-alignment position, the rotating shaft 52 drives the claw disc 60 to rotate, and the optical-mechanical assembly 40 captures the notch information of the silicon wafer and the edge information of the silicon wafer, and sends the captured notch information and edge information of the silicon wafer to the controller.

In step S118, the controller calculates an eccentricity tolerance of the silicon wafer based on the notch information and the edge information of the silicon wafer, and when the eccentricity tolerance of the silicon wafer satisfies a preset condition, the rotating shaft 52 rotates to rotate the notch of the silicon wafer to a position under the optical-mechanical assembly 40.

When the eccentricity tolerance of the silicon wafer satisfies a preset condition, the center of the silicon wafer is determined, and the notch of the silicon wafer is rotated below the optical-mechanical assembly 40 to perform step S19. When the eccentricity tolerance does not satisfy the preset condition, step S12 to step S17 are repeated until the eccentricity tolerance of the silicon wafer satisfies the preset condition.

In step S19, the rotating shaft 52 rotates back and forth in small angles, the optical-mechanical assembly 40 captures and sends the notch information of the silicon wafer to the controller, the controller calculates a notch position error of the silicon wafer based on the notch information of the silicon wafer, and the rotating shaft 52 rotates to compensate for the notch position error thus completing orientation of the silicon wafer.

In one embodiment, the method further includes prior to step S14: the first absorption assemblies 62 overlap with the second absorption assemblies 71 in the radial direction, the rotating shaft 52 is operative to drive the claw disk 60 to rotate by a predetermined angle to stagger the first absorption assemblies 62 and the second absorption assemblies 71 in position.

5 Further, in step S15, the method further include the following operations subsequent to the operation of the lifting shaft 20 continuing to descend to the handover lower position: the rotating shaft 52 drives the claw disc 60 to continue rotating in the same direction by the predetermined angle; further, the operation subsequent to step S16 includes: the rotating shaft 52 drives the claw disc 60 to rotate in the reverse direction by the predetermined angle; specifically, step S17 is performed subsequent to the operation of the rotating shaft 52 driving the claw disc 60 to rotate in the reverse direction by the predetermined angle; specifically, in the present embodiment, in order to prevent the claw disk 60 from interfering with the second absorption assemblies 71 during the descending process, the claw disk 60 is first rotated by a predetermined angle, further, in order to prevent the claw disc 60 from interfering during the ascending, and after descending and transferring the silicon wafer to the annular suction disc 70, the claw disk 60 continued to rotate in the same direction at the same angle as before the descending. Finally, after the silicon wafer is transferred back to the claw disk 60 by the annular suction disc 70, the claw disk 60 is again rotated reversely by the same angle to return the silicon wafer to the original detecting position. Specifically, in one embodiment, the predetermined angle is less than a third of the angle between two adjacent first absorption assemblies 62.

In one embodiment, the pre-alignment method further includes the following operation prior to the operation of the claw disc receiving the silicon wafer: adjusting the position adjustment assembly 80 according to a size of the silicon wafer, to adjust the optical-mechanical assembly 40 to a position corresponding to the size of the silicon wafer. Specifically, when the pre-alignment apparatus as illustrated in FIG. 5 is employed, adjusting the optical-mechanical assembly 40 to the corresponding position according to the size of the silicon wafer before the claw disk 60 receives the silicon wafer. Further, when the pre-alignment apparatus as illustrated in FIG. 5 is employed, according to the size of the silicon wafer, in the above-mentioned step of performing the silicon wafer transferring, the third absorption assemblies 65 may be turned on or turned off, or the third absorption assemblies may be turned on or turned off at the same time to complete the transfer of the silicon wafer between the claw disk 60 and the annular suction disc 70.

The above-mentioned pre-alignment apparatus is capable of performing absorption positioning and flattening on a large warping wafer, satisfying the pre-alignment positioning requirements of the large warping wafer, and improving the pre-alignment precision of the large warping wafer. The pre-alignment method based on the pre-alignment apparatus may perform
5 absorption positioning and flattening on the large warping wafer, and improve the pre-alignment precision of the large warping wafer.

The technical features of the above embodiments may be combined in an arbitrary manner. For the brevity of description, all possible combinations of the technical features in the above embodiments are not described. However, as long as the combinations of these technical
10 features do not result in a conflict, these combinations should be considered to fall in the scope of the present disclosure.

The above embodiments are merely some embodiments of the present disclosure, and the specific and detailed description thereof cannot be understood as limiting the scope of the present disclosure. It is to be noted that for those skilled in the art, numerous improvements and
15 modifications can be made without departing from the principle of the present disclosure, and these improvements and modifications shall fall in the scope of the present disclosure. Therefore, the scope of protection of the present disclosure is defined by the appended claims.

What is claimed is:

1. A pre-alignment apparatus, comprising: a bottom plate (10), a lifting shaft (20) arranged on the bottom plate (10), a compensation shaft (30), and an optical-mechanical assembly (40), the pre-alignment apparatus further comprising:

5 a rotating shaft assembly (50), comprising a rotating shaft (51) and an extension rod (52), wherein the rotating shaft (51) is arranged on the lifting shaft (20), and an end of the extension rod (52) is connected to the rotating shaft (51);

10 a claw disc (60), connected to another end of the extension rod (52), wherein a plurality of first absorption assemblies (62) are arranged at intervals along a circumference of the claw disk (60); and

15 an annular suction disc (70), connected to the compensation shaft (30), wherein a plurality of second absorption assemblies (71) are arranged on the annular suction disc (70), wherein the annular suction disc (70) has a diameter smaller than that of a distribution circle of the claw disk (60), the annular suction disc (70) is sleeved around the rotating shaft assembly (50), and there is formed a gap between the annular suction disc (70) and the rotating shaft assembly (50);

20 wherein the rotating shaft assembly (50) is operative to drive the claw disk (60) to rotate, the lifting shaft (20) is operative to drive the claw disk (60) to perform an ascending or descending motion in a vertical direction, the compensation shaft (30) is operative to drive the annular suction disc (70) to move in a horizontal direction, and the claw disk (60) is provided with a handover gap configured for the second absorption assembly (71) to pass through when transferring a silicon wafer between the claw disk (60) and the annular suction disc (70).

25 2. The pre-alignment apparatus of claim 1, wherein the first absorption assembly (62) and/or the second absorption assembly (71) each comprise a rigid strut (621) and a rubber suction disc (624), wherein the rigid strut (621) is provided with a first vent hole (626), the rubber suction disc (624) is connected to the rigid strut (621) and is in communication with the first vent hole (626).

30 3. The pre-alignment apparatus of claim 1, wherein the first absorption assembly (62) and/or the second absorption assembly (71) each comprise a rigid strut (621), an elastic member (622), an elastic strut (623), and a rubber suction disc (624), wherein the elastic member (622) is arranged inside the rigid strut (621), the elastic strut (623) is provided with a second vent hole (625), one end of the elastic strut (623) is arranged inside the rigid strut (621) and is sleeved by the elastic member (622), and another end of the elastic strut (623) is arranged outside the rigid

strut (621) and is connected to the rubber suction disc (624), wherein rubber suction disc (624) is in communication with the second vent hole (625).

4. The pre-alignment apparatus according to claim 1, wherein the claw disc (60) is further provided with a third absorption assembly (65), wherein a center of the third absorption assembly (65), a center of the corresponding first absorption assembly (62), and a center of the claw disk (60) are collinear, and the third absorption assembly is disposed between the corresponding first absorption assembly and the center of the claw disc (60).

5. The pre-alignment apparatus of claim 4, wherein the third absorption assembly (65) comprises a rigid strut (621) and a rubber suction disc (624), wherein the rigid strut (621) is provided with a first vent hole (626), wherein the rubber suction disc (624) is connected to the rigid strut (621) and is in communication with the first vent hole (626).

6. The pre-alignment apparatus of claim 4, wherein the third absorption assembly (65) comprise a rigid strut (621), an elastic member (622), an elastic strut (623), and a rubber suction disc (624), wherein the elastic member (622) is arranged inside the rigid strut (621), the elastic strut (623) is provided with a second vent hole (625), one end of the elastic strut (623) is arranged inside the rigid strut (621) and is sleeved by the elastic member (622), and another end of the elastic strut (623) is arranged outside the rigid strut (621) and is connected to the rubber suction disc (624), wherein the rubber suction disc (624) is in communication with the second vent hole (625).

7. The pre-alignment apparatus of claim 4, further comprising a position adjustment assembly comprising a slide rail (81), a slide block (82), and a driving member (83), wherein the slide rail (81) is connected to the bottom plate (10), the slide block (82) is operative to slide on the slide rail (81), the optical-mechanical assembly (40) is mounted on the slide block (82), and the driving member (83) is connected to the slide block (82).

8. The pre-alignment apparatus of claim 4, comprising an air slip ring, which is sleeved on an inner side of the extension rod (52) and is in communication with each of the first absorption assembly (62) and the third absorption assembly (65).

9. The pre-alignment apparatus of claim 1 or 4, further comprising a sensor (200) and a blocking piece (300), wherein the sensor (200) is arranged on the annular suction disc (70) or the second absorption assembly (71), and the blocking piece (300) is arranged on the claw disk (60); or the sensor (200) is arranged on the claw disk (60), and the blocking piece (300) is arranged on the annular suction disc (70) or the second absorption assembly (71); wherein when the first absorption assemblies (62) overlap with the second absorption assemblies (71) in a

radial direction, the blocking piece (300) is operative to trigger the sensor (200).

10. The pre-alignment apparatus of claim 1, wherein the claw disk (60) comprises at least a plurality of claw rods (61) outwardly divergently distributed from the center of the claw disc (60), wherein the handover gap is defined between adjacent claw rods (61), and each of the first
5 absorption assemblies (62) is arranged at an end of the corresponding claw rod (61).

11. The pre-alignment apparatus of claim 10, wherein a reinforcing rib (66) is arranged between adjacent claw rods (61).

12. The pre-alignment apparatus of claim 1 or 4, wherein a rigid support block (64) is provided at a center of the claw disk (60).

10 13. The pre-alignment apparatus of claim 1 or 4, wherein when transferring the silicon wafer between the claw disk (60) and the annular suction disc (70) and the first absorption assemblies (62) overlaps with the second absorption assembly (71) in the radial direction, the rotating shaft (51) is operative to drive the claw disk (60) to rotate by a predetermined angle to
15 stagger the first absorption assemblies (62) and the second absorption assemblies (71) in position, wherein the predetermined angle is less than a third of an angle between two adjacent first absorption assemblies (62).

14. A pre-alignment method based on the pre-alignment apparatus of any one of claims 1 to 13, the pre-alignment method comprising the following operations:

receiving, by the claw disc (60), a silicon wafer;

20 driving, by the rotating shaft (51), the claw disc (60) to rotate, and capturing, by the optical-mechanical assembly (40), edge information of the silicon wafer and sending the captured edge information of the silicon wafer to a controller;

calculating, by the controller, an eccentricity of the silicon wafer based on the received edge information of the silicon wafer, controlling rotation of the rotating shaft (51) according to
25 the eccentricity, and rotating a direction of the silicon wafer having a maximum eccentricity in line with a moving direction of the compensation shaft (30);

descending, by the lifting shaft (20), to a handover position, and transferring, by the claw disc (60), the silicon wafer to the annular suction disc (70);

driving, by the lifting shaft (20), the claw disc (60) to continue to descend to a handover
30 lower position, and driving, by the compensation shaft (30), the annular suction disc (70) into

motion to compensate for the eccentricity of the silicon wafer;

driving, by the lifting shaft (20), the claw disc (60) to ascend to the handover position, and transferring, by the annular suction disc (70), the silicon wafer to the claw disc (60);

5 driving, by the lifting shaft (20), the claw disc (60) to continue to ascend to a pre-alignment position, driving, by the rotating shaft (51), the claw disc (60) to rotate, and capturing, by the optical-mechanical assembly (40), notch information of the silicon wafer and the edge information of the silicon wafer, and sending the captured notch information and edge information of the silicon wafer to the controller;

10 calculating, by the controller, an eccentricity tolerance of the silicon wafer based on the notch information and the edge information of the silicon wafer, and when the eccentricity tolerance of the silicon wafer satisfies a preset condition, rotating, by the rotating shaft (51), to rotate the notch of the silicon wafer to a position under the optical-mechanical assembly (40); and

15 rotating, by the rotating shaft (51), back and forth in small angles, capturing and sending, by the optical-mechanical assembly (40), the notch information of the silicon wafer to the controller, calculating, by the controller, a notch position error of the silicon wafer based on the notch information of the silicon wafer, and rotating, by the rotating shaft (51), to compensate for the notch position error thus completing orientation of the silicon wafer.

20 15. The pre-alignment method of claim 14, further comprising the following operation prior to the operation of the lifting shaft (20) ascending to the handover position and the claw disk (60) transferring the silicon wafer to the annular suction disk (70): driving, by the rotating shaft (51), the claw disk (60) to rotate by the predetermined angle to stagger the first absorption assemblies (62) and the second absorption assemblies (71) in position when the first absorption assemblies (62) overlap with the second absorption assemblies (71) in the radial direction;

25 wherein the pre-alignment method further comprises the following operation subsequent to the operation of the lifting shaft (20) driving the claw disc (60) to continue to descend to the handover lower position: driving, by the rotating shaft (51), the claw disc (60) to continue rotating in the same direction by the predetermined angle;

30 wherein the pre-alignment method further comprises the following operation subsequent to the operation of the lifting shaft (20) driving the claw disc (60) to ascend to the handover position, and the annular suction disc (70) transferring the silicon wafer to the claw disc (60): driving, by the rotating shaft (51), the claw disc (60) to rotate in a reverse direction by the

predetermined angle.

16. The pre-alignment method of claim 15, wherein the predetermined angle is less than a third of an angle between two adjacent first absorption assemblies (62).

5 17. The pre-alignment method of claim 14, wherein the operation of the claw disc (60) receiving the silicon wafer comprises: placing, by a wafer fork, the silicon wafer on the claw disk (60), and creating, by the first absorption assemblies (62), a vacuum to absorb the silicon wafer.

18. The pre-alignment method of claim 14, wherein the operation of the claw disc (60) receiving the silicon wafer comprises:

10 driving, by the lifting shaft (20), the claw disc (60) to descend to a wafer-mounted position; placing, by the wafer fork, the silicon wafer on the annular suction disc (70), and creating, by the second absorption assemblies (71), a vacuum to absorb the silicon wafer;

15 driving, by the lifting shaft (20), the claw disc (60) to ascend to the handover position; creating, by the first absorption assemblies (62), a vacuum to absorb the silicon wafer; turning off, by the second absorption assembly (71), the vacuum, and driving, by the lifting shaft (20), the claw disc (60) to ascend to the pre-alignment position.

20 19. The pre-alignment method of claim 14, further comprising the following operation prior to the operation of the claw disc (60) receiving the silicon wafer: adjusting the position adjustment assembly according to a size of the silicon wafer, to adjust the optical-mechanical assembly (40) to a position corresponding to the size of the silicon wafer.