

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims priority to Chinese patent application No. 201811614342.7 filed on December 27, 2018, disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to the field of integrated circuit manufacturing, particularly to a pre-alignment apparatus and a method for a warped wafer.

BACKGROUND

In the production process of semiconductor apparatus, in order to ensure that a silicon wafer can be exposed in a fixed posture, the silicon wafer needs to be transferred to a workpiece stage with higher centering and orientation precision during the transfer process. Since a position and a direction of the silicon wafer are not certain when the silicon wafer is placed into a silicon wafer groove, a pre-alignment with a certain precision needs to be performed on the silicon wafer before the silicon wafer is transferred to the workpiece stage. Namely, a current position of the silicon wafer is determined by measuring a center of the silicon wafer, and the direction of the silicon wafer is determined by measuring a direction of a notch of the silicon wafer.

With the development of the semiconductor industry, there are more and more kinds of silicon wafer. In order to meet the positioning requirements of various process wafers such as a warped wafer and a thin wafer, CN Pat. No. 105336654A discloses a pre-alignment apparatus suitable for various process types of silicon wafers. By arranging a ceramic suction cup and a half-moon suction cup, the apparatus performs a multi-point adsorbing positioning on the silicon wafer to meet the positioning requirements of the different types of process silicon wafers, which can adapt to the pre-alignments of various process suction cups. However, in recent years, the appearance of a large warped wafer raises new demands on the adaptability of the pre-alignment apparatus. When the pre-alignment is performed on the large warped wafer, in order to ensure the precision of the pre-alignment, a planarization treatment needs to be performed on the warped wafer. In order to realize the planarization treatment of warped wafer, the warped wafer needs to be adsorbed at a region near an edge of the warp wafer so as to planarize the warped wafer, which needs to increase a diameter of a distribution circle of the ceramic suction cup. However, the half-moon suction cup of the apparatus is arranged around an outer side of the ceramic suction cup. If the diameter of the distribution circle of the ceramic suction cup is

increased, in order to avoid inference between the ceramic suction cup and the half-moon suction cup, a diameter of a distribution circle of the half-moon suction cup needs to be increased correspondingly. However, if the diameter of the distribution circle of the half-moon suction cup is increased, the diameter of distribution circle of the half-moon suction cup would be greater than a diameter of the warped wafer, and a situation that the half-moon suction cup is located on an outer side of a distribution region of the warped wafer and cannot adsorb the warped wafer would occur. Therefore, the existing pre-alignment apparatus for the silicon wafer cannot meet the pre-alignment positioning requirements of the large warped wafer.

10 SUMMARY

An object of the present disclosure is to provide a pre-alignment apparatus and a method for a warped wafer, which can perform the adsorption positioning and planarization treatment on a large warped wafer, meets the pre-alignment positioning requirements of the large warped wafer, and improve the pre-alignment precision of the large warped wafer.

15 In order to achieve this object, in one aspect, the technical scheme adopted by the present disclosure is as follows.

Provide is a pre-alignment apparatus for a warped wafer, including:

20 an air nozzle assembly, configured to blow air to an edge of one side of a warped wafer, and apply pressure to the edge of the one side of the warped wafer, so as to planarize a region of the edge of the warped wafer; and

a roller assembly, arranged corresponding to the air nozzle assembly along a vertical direction, and configured to, in condition that the air nozzle assembly blows the air to the warped wafer, support the edge of the warped wafer on another side of the warped wafer.

25 In one embodiment, the pre-alignment apparatus for a warped wafer further includes: a bottom plate, a lifting shaft, a rotating shaft, a rotating disk, a compensating disk assembly, and an optomechanical assembly. The lifting shaft, the compensating disk assembly and the optomechanical assembly are arranged on the bottom plate. The rotating shaft is connected to the lifting shaft. The rotating disk is connected to the rotating shaft. And the air nozzle assembly and the roller assembly are arranged on an optomechanical bracket of the optomechanical assembly.

30 In one embodiment, the air nozzle assembly includes an air nozzle supporting member and an air nozzle. The air nozzle supporting member is connected to the optomechanical bracket, and the air nozzle is mounted on the air nozzle supporting member.

The roller assembly includes a roller supporting member and a supporting roller. The roller

supporting member is connected to the optomechanical bracket. The supporting roller is mounted on the roller supporting member, and a spherical top surface of the supporting roller is arranged opposite to an air outlet of the air nozzle.

5 In one embodiment, the air nozzle assembly includes a plurality of air nozzles. The plurality of air nozzles are distributed in a circular arc shape on the air nozzle supporting member, and a distribution circle in which the plurality of air nozzles are located is concentric with the rotating disk.

10 In one embodiment, distances from air outlet surfaces of the plurality of air nozzles to a rotating disk warped wafer rigid supporting surface are different. In condition that one air nozzle is nearer to the optomechanical bracket than another air nozzle, a distance from an air outlet surface of the one air nozzle to the rotating disk warped wafer rigid supporting surface is less than a distance from an air outlet surface of the another air nozzle to the rotating disk warped wafer rigid supporting surface.

15 In one embodiment, the supporting roller and one of the plurality of air nozzles closest to the optomechanical bracket are coaxially arranged along the vertical direction. In condition that the one of the plurality of the air nozzles blows the air to the warped wafer, the spherical top surface of the supporting roller and the rotating disk warped wafer rigid supporting surface are located on a same plane.

20 In one embodiment, the roller assembly further includes a plurality of auxiliary rollers. The plurality of auxiliary rollers are arranged corresponding to other air nozzles other than the one of the plurality of air nozzles closest to the optomechanical bracket, respectively. Each of the other air nozzles and a corresponding auxiliary roller are coaxially arranged along the vertical direction. A spherical top surface of a respective auxiliary rollers is not coplanar with the spherical top surface of the supporting roller, and in condition that one auxiliary roller is nearer to the supporting roller than another auxiliary roller, a distance from a spherical top surface of the one auxiliary roller to the rotating disk warped wafer rigid supporting surface is greater than a distance from a spherical top surface of the another auxiliary roller to the rotating disk warped wafer rigid supporting surface.

25 30 In one embodiment, the roller supporting member and the air nozzle supporting member are both provided with a light passing hole.

In one embodiment, the roller assembly further includes a lifting driving member. The lifting driving member is connected to the optomechanical bracket and the roller supporting member respectively.

35 In one embodiment, the pre-alignment apparatus for a warped wafer further includes a switching shaft. The switching shaft is arranged between the bottom plate and the optomechanical assembly.

In another aspect, provided is a pre-alignment method for a warped wafer, including the following:

an air nozzle assembly is provided with a positive pressure and blows air to an edge of one side of a warped wafer, so as to planarize a region of the edge of the warped wafer; and

5 a roller assembly supports the warped wafer on another side of the warped wafer.

In one embodiment, the pre-alignment method for a warped wafer, including the following:

A rotating disk receives the warped wafer.

The planarization treatment is executed.

10 A rotating shaft drives the rotating disk to continuously rotate for one revolution. The roller assembly supports the warped wafer when the rotating shaft rotates. And an optomechanical assembly collects edge information of the warped wafer when the rotating shaft rotates and sends the collected edge information of the warped wafer to a controller to calculate an eccentricity.

15 A lifting shaft drives the rotating disk to descend to a handover operation position, and the warped wafer is handed over to a compensating disk from the rotating disk.

The lifting shaft drives the rotating disk to continue to descend to a handover low position, and a compensating shaft is moved to compensate the eccentricity of the warped wafer.

20 The lifting shaft drives the rotating disk to ascend to a handover operation position, the warped wafer is handed over to the rotating disk from the compensating disk, and the lifting shaft drives the rotating disk to continue to ascend to a pre-alignment operation position.

The planarization treatment is executed.

25 the rotating shaft drives the rotating disk to rotate, the roller assembly supports the warped wafer when the rotating shaft rotates, and the optomechanical assembly collects notch information of the warped wafer and the edge information of the warped wafer and sends the collected notch information of the warped wafer and the collected edge information of the warped wafer to the controller.

30 The controller calculates an eccentricity allowance of the warped wafer based on the collected notch information of the warped wafer and the collected edge information of the warped wafer, when the eccentricity allowance of the warped wafer satisfies a preset condition, the rotating shaft rotates a notch of the warped wafer to a lower side of the optomechanical assembly.

The rotating shaft is rotated back and forth by a small angle, the optomechanical assembly collects the notch information of warped wafer and sending the notch information of warped wafer to the controller, the controller calculates a notch position error of the warped wafer based

on the notch information of the warped wafer, the rotating shaft is rotated to compensate the notch position error, and an orientating of the warped wafer is finished.

In one embodiment, the pre-alignment method for a warped wafer, further including:

5 before the planarization treatment is executed, the roller assembly is ascended to a high position and the roller assembly supports warped wafer; and

before the lifting shaft drives the rotating disk to descend to a handover operation position and the warped wafer is handed over to the compensating disk from the rotating disk, the roller assembly is descended to a low position.

In one embodiment, the pre-alignment method for a warped wafer, further including:

10 before the rotating disk receives the warped wafer, a switching shaft is adjusted based on a size of the warped wafer, and the optomechanical assembly is adjusted to be on an operation position corresponding to the size of the warped wafer.

15 The process of performing the planarization treatment on the warped wafer by the pre-alignment apparatus for a warped wafer is as follows. The air nozzle assembly is provided with the positive pressure, blows the air to the edge of the warped wafer, and applies pressure on the edge of the warped wafer, so as to planarize the region of the edge of the warped wafer. Meanwhile, the roller assembly supports the warped wafer on the other side of the warped wafer, to prevent the edge of the warped wafer from being stressed to be deformed or damaged.

20 Through the air nozzle assembly and the roller assembly performing the edge planarization treatment on the warped wafer, the pre-alignment apparatus for the warped wafer can realize the adsorption positioning and planarization treatment on the large warped wafer. Compared to the existing alignment apparatus for a warped wafer, the above pre-alignment apparatus for a warped wafer can realize the adsorption positioning and planarization treatment on the large warped wafer, meet the pre-alignment positioning requirements for the large warped wafer, and
25 improve the pre-alignment precision of the large warped wafer. The above pre-alignment method for the warped wafer can perform the adsorption positioning and planarization treatment on the large warped wafer, and improve the pre-alignment precision of the large warped wafer.

BRIEF DESCRIPTION OF DRAWINGS

30 Fig. 1 is a structural schematic diagram illustrating a pre-alignment apparatus for a warped wafer according to one embodiment of the present disclosure.

Fig. 2 is a structural sectional view illustrating a pre-alignment apparatus for a warped wafer according to one embodiment of the present disclosure.

Fig. 3 is a top view illustrating a pre-alignment apparatus for a warped wafer according to one

embodiment of the present disclosure.

Fig. 4 is a layout schematic diagram illustrating an air nozzle assembly and a roller assembly according to one embodiment of the present disclosure.

Fig. 5 is a structural schematic diagram illustrating a pre-alignment apparatus for a warped wafer according to another embodiment of the present disclosure.

Fig. 6 is a flow chart illustrating a pre-alignment method for a warped wafer according to one embodiment of the present disclosure.

Description of reference numerals:

10-bottom plate; 20-lifting shaft; 30-rotating shaft; 40-rotating disk; 50-compensating disk assembly; 60-optomechanical assembly; 70-air nozzle assembly; 80-roller assembly; 90-warped wafer; 100-switching shaft; 110-rotating disk warped wafer rigid supporting surface; 41-rubber suction cup; 51-compensating shaft; 52-compensating disk; 53-small rubber suction cup; 61-optomechanical bracket; 62-first light source; 63-lens; 64-CCD camera; 65-second light source; 71-air nozzle supporting member; 72-first air nozzle; 73-second air nozzle; 74-third air nozzle; 75-fourth air nozzle; 81-roller supporting member; 82-supporting roller; 83-auxiliary roller; 84-lifting driving member.

DETAILED DESCRIPTION

Hereinafter the technical solutions of the present disclosure will be further described in detail in conjunction with accompanying drawings and embodiments.

In the description of the present disclosure, it is necessary to note that orientation or position relationships indicated by terms such as 'up', 'down', 'front', 'rear', 'left', 'right', 'vertical', 'horizontal', 'top', 'bottom', 'interior' and 'exterior' are orientation or position relationships shown on the basis of the drawings, are only used for conveniently describing the present disclosure and simplifying description without indicating or suggesting that appointed apparatus or elements must have specific orientations or be constructed and operated at the specific orientations, therefore, the terms cannot be understood to limit the present disclosure.

Referring to Fig. 1 to Fig. 3, a pre-alignment apparatus for a warped wafer in one embodiment includes an air nozzle assembly 70 and a roller assembly 80. The air nozzle assembly 70 is configured to blow air to an edge of the warped wafer 90, and apply pressure to the edge of the warped wafer 90, so as to planarize a region of the edge of the warped wafer 90. The roller assembly 80 is arranged in a vertical direction corresponding to the air nozzle assembly 70. The roller assembly 80 is configured to, in condition that the air nozzle assembly 70 blows the air to

one side of the warped wafer 90, support the edge of the warped wafer 90 on another side of the warped wafer 90.

The process of performing the planarization treatment on the warped wafer by the pre-alignment apparatus for the warped wafer is as follows. The air nozzle assembly 70 is provided with positive pressure, blows air to the edge of the warped wafer 90, applies pressure to the edge of the warped wafer 90, and planarize the area of the edge of the warped wafer 90. At the same time, the roller 80 is located on the other side of the warped wafer 90 to support the edge of the warped wafer 90 so as to prevent the edge of the warped wafer 90 from being stressed to be deformed or damaged. Through the air nozzle assembly 70 and the roller assembly 80 performing the edge planarization treatment on the warped wafer 90, the pre-alignment apparatus for the warped wafer can realize the adsorption positioning and planarization treatment on a large warped wafer, meet the pre-alignment positioning requirements for the large warped wafer, and improve the pre-alignment precision of the large warped wafer.

In one embodiment, the pre-alignment apparatus for the warped wafer further includes a bottom plate 10, a lifting shaft 20, a rotating shaft 30, a rotating disk 40, a compensating disk assembly 50, and an optomechanical assembly 60. The lifting shaft 20, the compensating disk assembly 50, and the optomechanical assembly 60 are arranged on the bottom plate 10. The rotating shaft 30 is connected to the lifting shaft 20. The rotating disk 40 is connected to the rotating shaft 30. The air nozzle assembly 70 and the roller assembly 80 are arranged on an optomechanical bracket 61 of the optomechanical assembly 60.

In one embodiment, the compensating disk assembly 50 includes a compensating shaft 51 and a compensating disk 52. The compensating shaft 51 is mounted on the bottom plate 10. The compensating disk 52 is mounted on the compensating shaft 51. The compensating disk 52 is provided with a small rubber suction cup 53. The compensating disk 52 is configured to absorb and fix the warped wafer 90 through the small rubber suction cup 53. The compensating shaft 51 is configured to drive the compensating disk 52 to move so as to perform eccentricity compensation on the warped wafer 90. The lifting shaft 20 is a handover shaft for the warped wafer 90, which is used for realizing the mutual handover of the warped wafer 90 between the rotating disk 40 and the compensating disk 52. The rotating disk 40 is provided with a rubber suction cup 41. The rotating disk 40 is located in a central region of the warped wafer 90 to absorb and fix the warped wafer 90 through the rubber suction cup 41. The rotating shaft 30 is configured to drive the rotating disk 40 to rotate, and perform bias error compensation on the warped wafer 90.

The optomechanical assembly 60 is arranged adjacent to the lifting shaft 20, and configured to,

when a warped wafer with a large warpage rotates, collect defect information (including edge information and notch information) of the warped wafer with a large warpage, and sends the collected edge information to a controller. The controller is configured to perform calculation based on the collected edge information of the warped wafer with a large warpage, so as to
5 obtain a center and direction of the warped wafer with a large warpage. In one embodiment, the controller may be a control module integrated in a lithography machine controller, and may also be an independently arranged controller of the pre-alignment apparatus for the warped wafer, which is not specifically limited in the present embodiment.

In one embodiment, the optomechanical assembly 60 includes the optomechanical bracket 61, a
10 first light source 62, a lens 63, a CCD camera 64, and a second light source 65. The optomechanical bracket 61 is mounted on the bottom plate 10. The CCD camera 64 is mounted on the optomechanical bracket 61. The first light source 61 and the lens 63 are mounted on the CCD camera 64. The second light source 65 is mounted on the optomechanical bracket 61. The CCD camera 64 is configured to collect an image of the warped wafer with a large warpage,
15 acquire the edge information and notch information of the warped wafer with a large warpage, and send the acquired edge information and notch information to the controller.

In one embodiment, the air nozzle assembly 70 includes an air nozzle supporting member 71 and an air nozzle. The air nozzle supporting member 71 is connected to the optomechanical bracket 1. The air nozzle is mounted on the air nozzle supporting member 71 and connected to
20 an air nozzle joint. The roller assembly 80 includes a roller supporting member 81 and a supporting roller 82. The roller supporting member 81 is connected to the optomechanical bracket 61. The supporting roller 82 is mounted on the roller supporting member 81. A spherical top surface of the supporting roller 82 is arranged opposite to an air outlet of the air nozzle. In one embodiment, the air nozzle assembly 70 is mounted below the CCD camera 64. The air
25 nozzle assembly 72 is located above the rotating disk 40. The air nozzle blows air to an upper surface of the warped wafer 90 when the warped wafer 90 rotates, so as to perform planarization treatment on an edge within a collecting region of the optical system. The roller assembly 80 is located below the air nozzle assembly 70. In condition that the air nozzle blows air to the upper surface of the warped wafer 90, the spherical top surface of the supporting roller 82 is on a same
30 plane as a rotating disk warped wafer rigid supporting surface 110, and the supporting roller 82 is configured to, in condition that the warped wafer 90 rotates, support the warped wafer 90, so as to prevent the edge of the warped wafer 90 from being stressed to be deformed or damaged. In one embodiment, when the warped wafer 90 rotates, the supporting roller 82 generates rolling friction with a lower surface of the warped wafer 90, which can ensure the warped wafer
35 90 to rotate smoothly.

In one embodiment, the air nozzle assembly 70 includes a plurality of air nozzles. The plurality of air nozzles are distributed in a circular arc shape on the air nozzle supporting member 71, and a distribution circle in which the plurality of air nozzles are located is concentric with the rotating disk 40. As shown in Fig. 1 and Fig. 3, in the present embodiment, the air nozzle assembly 70 includes four air nozzles which are a first air nozzle 72, a second air nozzle 73, a third air nozzle 74, and a fourth air nozzle 75 respectively. The first air nozzle 72, the second air nozzle 73, the third air nozzle 74, and the fourth air nozzle 75 are distributed in a circular arc shape on the air nozzle supporting member 71, and a distribution circle in which the first air nozzle 72, the second air nozzle 73, the third air nozzle 74, and the fourth air nozzle 75 are located is concentric with the rotating disk 40. In one embodiment, the distribution circle in which the first air nozzle 72, the second air nozzle 73, the third air nozzle 74, and the fourth air nozzle 75 are located is concentric with the rotating disk 40, which can realize that the four air nozzles blow air to the edge of the warped wafer 90 in sequence when the warped wafer 90 rotates, keeping the edge of the warped wafer 90 within a detecting region of the optical system in a planarized state, and improving the planarization precision of the warped wafer 90. In another embodiment, the first air nozzle 72, the second air nozzle 73, the third air nozzle 74, and the fourth air nozzle 75 are symmetrically distributed on two sides of the CCD camera 64 in two groups, which can ensure that the warped wafer 90 is uniformly stressed.

In one embodiment, distances from respective air outlet surfaces of the plurality of the air nozzles to the rotating disk warped wafer rigid supporting surface 110 are different, and in condition that one air nozzle is nearer to the optomechanical bracket 61 than another air nozzle, a distance from an air outlet surface of the one air nozzle to the rotating disk warped wafer rigid supporting surface 110 is less than a distance from an air outlet surface of the another air nozzle to the rotating disk warped wafer rigid supporting surface 110. In the present embodiment, in condition that one air nozzle is farther from the optomechanical bracket 61 than another air nozzle, the distance from an air outlet surface of the one air nozzle to the rotating disk warped wafer rigid supporting surface 110 is greater than the distance from an air outlet surface of the another air nozzle to the rotating disk warped wafer rigid supporting surface 110, which can realize that the stepwise pressure application and the stepwise pressure release are performed on the edge of the warped wafer 90, and the cushioning protection is formed on the warped wafer 90, so as to avoid the damage to the warped wafer 90 due to sudden press or sudden loss of pressure on the edge of the warped wafer 90.

In one embodiment, as shown in Fig. 3 and Fig. 4, the second air nozzle 73 and the third air nozzle 74 are arranged nearer to the optomechanical bracket 61 than the first air nozzle 72 and the fourth air nozzle 75, and a distance from the second air nozzle 73 to the optomechanical

5 bracket 61 is the same as a distance from the third air nozzle 74 to the optomechanical bracket 61. Thus, a distance from an air outlet surface of the second air nozzle 73 to the rotating disk warped wafer rigid supporting surface 110 is the same as a distance from an air outlet surface of the third air nozzle 74 to the rotating disk warped wafer rigid supporting surface 110, which are D1. Similarly, the first air nozzle 72 and the fourth air nozzle 75 are arranged farther from the optomechanical bracket 61 than the second air nozzle 73 and the third air nozzle 74, and a distance from the first air nozzle 72 to the optomechanical bracket 61 is the same as a distance from the fourth air nozzle 75 to the optomechanical bracket 61. A distance from an air outlet surface of the first air nozzle 72 to the rotating disk warped wafer rigid supporting surface 110 is the same as a distance from an air outlet surface of the fourth air nozzle 75 to the rotating disk warped wafer rigid supporting surface 110, which are D2. In another embodiment, D1 is less than D2, namely, compared to the air outlet surfaces of the second air nozzle 73 and the third air nozzle 74, the air outlet surfaces of the first air nozzle 72 and the fourth 75 are farther from the rotating disk warped wafer rigid supporting surface 110. Correspondingly, when the air is blown to the warped wafer 90, compared to the air outlet surfaces of the second air nozzle 73 and the third air nozzle 74, the air outlet surfaces of the first air nozzle 72 and the fourth air nozzle 75 are farther from the surface of the edge of the warped wafer 90. In a pre-alignment process, the warped wafer 90 rotates clockwise, and the edge of the warped wafer 90 passes through the first air nozzle 72, the second air nozzle 73, the third air nozzle 74, and the fourth air nozzle 75 in sequence during the rotation process. The first air nozzle 72 firstly applies pressure to the edge of the warped wafer 90. Then the second air nozzle 73 applies pressure to the edge of the warped wafer 90. Since compared to the second air nozzle 73, the first air nozzle 72 is farther from the warped wafer 90, the pressure applied to the edge of the warped wafer 90 by the first air nozzle 72 is lower than the pressure applied to the edge of the warped wafer 90 by the second air nozzle 73. Thus the edge of the warped wafer 90 will not be completely planarized when passing through the first air nozzle 72, and will be completely planarized after rotating to the second air nozzle 73. The edge of the warped wafer 90 continues to rotate to a lower side of the third air nozzle 74, and a distance from the third air nozzle 74 to the edge of the warped wafer 90 is the same as a distance from the second air nozzle 73 to the edge of the warped wafer 90. Thus, pressure applied to the edge of the warped wafer 90 by the third air nozzle 74 is the same as pressure applied to the edge of the warped wafer 90 by the second air nozzle 73, keeping the edge of the warped wafer 90 in a planarized state, and ensuring that the edge of the warped wafer 90 remains planarized within an optical detecting region. When the edge of the warped wafer 90 continues to rotate to a lower side of the fourth air nozzle 75, pressure applied on the edge of the warped wafer 90 by the fourth air nozzle 75 is lower than pressure applied on

the edge of the warped wafer 90 by the third air nozzle 74. Thus the edge of the warped wafer 90 is deformed toward a warping direction. After the edge of the warped wafer 90 continues to rotate away from the lower side of the fourth air nozzle 75, the edge of the warped wafer 90 returns to a warped state.

5 It can be seen from a stress analysis of the edge of the warped wafer 90 during the rotation that, the first air nozzle 72 can form a pre-press on the edge of the warped wafer 90, and the first air nozzle 72 and the second air nozzle 73 can apply two levels of pressure on the edge of the warped wafer 90, so that the edge of the warped wafer 90 is slowly planarized during the rotation. Similarly, the fourth air nozzle 74 can form a pre-release on the edge of the warped
10 wafer 90, so that edge of the warped wafer 90 slowly returns to the warped state. Therefore, the first air nozzle 72 and the fourth air nozzle 75 can perform the pre-press and pre-release on the edge of the warped wafer 90, which can effectively prevent the warped wafer 90 from being damaged due to sudden press or sudden loss of pressure on the edge of the warped wafer 90, and effectively protect the warped wafer 90. In another embodiment, the air outlet of the air
15 nozzle is a slit air outlet, so that air can be uniformly blown to the edge of the warped wafer 90, and a situation that the air blown is concentrated at a certain point to cause stress concentration so as to cause the damage of the warped wafer will not occur, and the warped wafer 90 is further protected.

In one embodiment, the supporting roller 82 and an air nozzle closest to the optomechanical
20 bracket are coaxially arranged in a vertical direction. When the air nozzle blows air to the warped wafer, the spherical top surface of the supporting roller 82 and the rotating disk warped wafer rigid supporting surface 110 are located on the same plane. In another embodiment, as shown in Fig. 3, two supporting rollers 82 are provided. The two supporting rollers 82 are located below the second air nozzle 73 and the third air nozzle 74 respectively. The supporting
25 roller 82 is located below the edge of the warped wafer 90 to support the edge of the warped wafer 90, and the spherical top surface of the supporting roller 82 and the rotating disk warped wafer rigid supporting surface 110 are located on a same plane, which can ensure that the edge of the warped wafer 90 after being pressed and a center of the warped wafer 90 are located on a same plane, and effectively avoid over-planarization and ensure the planarization precision.

30 In one embodiment, the roller assembly further includes a plurality of auxiliary rollers 83. The plurality of auxiliary rollers 83 are arranged to be corresponding to air nozzles other than the air nozzle closest to the optomechanical bracket respectively. An auxiliary roller 83 and a corresponding air nozzle are coaxially arranged in the vertical direction. Spherical top surfaces of the plurality of auxiliary roller 83 are not coplanar with the spherical top surface of the

supporting roller 82. In condition that one auxiliary roller 83 is nearer to the supporting roller 82 than another auxiliary roller 83, a distance from a spherical surface of the one auxiliary roller 83 to the rotating disk warped wafer rigid supporting surface 110 is greater than a distance from a spherical surface of the another auxiliary roller 83 to the rotating disk warped wafer rigid supporting surface 110.

Referring to Fig. 1, Fig. 2 and Fig. 4, in the present embodiment, the roller assembly includes two auxiliary rollers 83. One of the two auxiliary rollers 83 is coaxially arranged with the first air nozzle 72, and another of the two auxiliary rollers 83 is coaxially arranged with the fourth air nozzle 75. Spherical top surfaces of the two auxiliary rollers 83 are arranged lower than the spherical top surface of the supporting roller 82. In another embodiment, some of warped wafers 90 may have a wavy warp on a surface thereof, and the surface of the warped wafer has a local upwarp and/or a local downwarp along a circumferential direction. The auxiliary roller 83 can support a local downwarped portion of the surface of the warped wafer 90 during an air blowing process of the first air nozzle 72 and the fourth air nozzle 75 to perform the pre-press and the pre-release on the edge of the warped wafer 90, thereby contributing to the improvement of the planarization effect of a warped wafer having a wavy warp.

In the above embodiments, four air nozzles are provided. It should be noted that, in other embodiments, more than or less than four air nozzles may be provided. In actual applications, a number of the air nozzles may be specifically arranged as needed. In one embodiment, in order to ensure the planarization effect, no less than three air nozzles are provided. In addition, in order to ensure that the warped wafer 90 is uniformly stressed during the rotation, an even number of air nozzles are provided. In another embodiment, a number of the supporting rollers 82 and a number of auxiliary rollers 83 are specifically arranged based on a number of and a layout of the air nozzles, which is not specifically limited in the above embodiments.

In one embodiment, the roller supporting member 81 and the air nozzle supporting member 71 are both provided with a light passing hole. In another embodiment, the roller supporting member 81 and the air nozzle supporting member 71 are provided with the light passing hole to provide an optical avoiding space for the optical system, so as to prevent the roller assembly 80 and the air nozzle assembly 70 from blocking light propagation of the optical system and from affecting collection precision of the optomechanical assembly 60. As shown in Fig. 1 and Fig. 3, in the present embodiment, the light passing hole is a circular arc shaped notch arranged at the roller supporting member 81 and the air nozzle supporting member 71 respectively. However, a specific shape of the light passing hole is not limited hereto, and can be arbitrarily arranged according to specific working conditions in actual applications, as long as the light propagation

of the optical system is not blocked.

In one embodiment, the roller assembly 80 further includes a lifting driving member 84. The lifting driving member 84 is connected to the optomechanical bracket 61 and the roller supporting member 81 respectively. In another embodiment, the lifting driving member 84 is mounted on the optomechanical bracket 61. The roller supporting member 81 is connected to the lifting driving member 84. The lifting driving member 84 is configured to drive the roller supporting member 81 to move up and down on the optomechanical bracket 61, to realize a switch of the roller assembly 80 from a high position to a low position. In another embodiment, the high position of the roller assembly 80 is a position at which the spherical top surface of the supporting roller 82 is located on a same plane as the rotating disk warped wafer rigid supporting plane 110, and the supporting roller 82 supports the warped wafer 90 when the roller assembly 80 is located at the high position. The low position of the roller assembly 80 is a position at which the spherical top surface of the supporting roller 82 is lower than a handover surface of the compensating disk 52, and, when the roller assembly 80 is at the low position a situation that the warped wafer 90 is interfered with the roller assembly 80 when the warped wafer 90 is handed over to the compensating disk 52 from the rotating disk 40 can be avoided. In one embodiment, the lifting driving member 84 may be, but not limited to, a lift cylinder.

In one embodiment, the pre-alignment apparatus of the warped wafer further includes a switching shaft 100. The switching shaft 100 is arranged between the bottom plate 10 and the optomechanical assembly 60. In one embodiment, the switching shaft 100 is fixed on the bottom plate 10. The optomechanical assembly 60 is slidably connected to the switching shaft 100. By adjusting a mounting position of the optomechanical assembly 60 on the switching shaft 100, an operation position switch of the optomechanical assembly 60 can be realized, so that operation positions of the optomechanical assembly 60 correspond to the warped wafers with different sizes (such as 8 inches and 12 inches).

The air nozzle assembly 70 of the pre-alignment apparatus for the warped wafer is located above the rotating disk 49, and the roller assembly 80 is located below the air nozzle assembly 70. The pre-alignment apparatus for the warped wafer is suitable for performing the planarization treatment on a warped wafer having a lower middle portion and a higher edge. As shown in Fig. 5, in another embodiment, the air nozzle assembly 70 of the pre-alignment apparatus for the warped wafer is located below the rotating disk, and the roller assembly 80 is located above the air nozzle assembly 70. The pre-alignment apparatus for the warped wafer in the present embodiment is suitable for performing the planarization treatment on a warped wafer having a higher middle portion and a lower edge. In another embodiment, the

pre-alignment apparatus for the warped wafer in the present embodiment and the pre-alignment apparatus for the warped wafer in the above embodiments only differ in that a mounting position of the air nozzle assembly 70 and a mounting position of the roller assembly 80 are different, and other structures and compositions of the pre-alignment apparatus for the warped wafer in the present embodiment and the pre-alignment apparatus for the warped wafer in the above embodiments are the same, which will not be described in detail herein.

In another aspect, further provided is a pre-alignment method for a warped wafer, including the following planarization treatment steps. The air nozzle assembly 70 is provided with a positive pressure, and blows the air to the edge of one side of the warped wafer 90, so as to planarize the edge region of the warped wafer 90. The roller assembly 80 supports the warped wafer 90 on the other side of the warped wafer 90. The pre-alignment method for the warped wafer can be realized based on the pre-alignment apparatus for the warped wafer, thereby performing adsorption positioning and planarization treatment on the large warped wafer and improving the pre-alignment precision of the large warped wafer.

In one embodiment, as shown in Fig. 6, the pre-alignment method for the warped wafer includes the following steps. (hereinafter, for convenience of description, the pre-alignment method for the warped wafer of the present disclosure is described by adopting the pre-alignment apparatus for the warped wafer as shown in Fig. 1.)

Step S11: the rotating disk 40 receives the warped wafer 90.

In one embodiment, after the warped wafer 90 is conveyed onto the rotating disk 40, the rotating disk 40 is provided with a vacuum, and the rubber suction cup 41 adsorbs the warped wafer 90.

Step S12: the planarization treatment steps are executed, and the planarization treatment is performed on the edge of the warped wafer 90.

In one embodiment, after the rotating disk 40 adsorbs and positions the warped wafer 90, the air nozzle assembly 70 is provided with the positive pressure, and the air nozzle blows air to the upper surface of the edge of the warped wafer 90. By the air nozzle applying the pressure on the upper surface of the edge of the warped wafer 90, the edge of the warped wafer within the collecting region of the optical system is planarized.

Step S13: the rotating shaft 30 drives the rotating disk 40 to rotate continuously for one revolution, the roller assembly 80 supports the warped wafer 90 when the rotating shaft 30 rotates. The optomechanical assembly 60 collects the edge information of the warped wafer 90 when the rotating shaft 30 rotates, and sends the collected edge information of the warped wafer to the controller to calculate the eccentricity.

Step S14: the lifting shaft 10 drives the rotating disk 40 to descend to a handover operation position, the warped wafer is handed over to the compensating disk 52 from the rotating disk 40.

5 In one embodiment, after the lifting shaft 10 drives the rotating disk 40 to descend to the handover operation position, the rotating disk 40 is not provided with the vacuum, and the rubber suction cup 41 releases the warped wafer 90. The compensating disk 52 is provided with the vacuum, the small rubber suction cup 53 adsorbs the warped wafer 90, and the warped wafer 90 is handed over to the compensating disk 52 from the rotating disk 40.

10 Step S15: the lifting shaft 20 drives the rotating disk 40 to continue to descend to a handover low position, the compensating shaft 51 moves to compensate the eccentricity of the warped wafer 90.

15 In one embodiment, the handover low position is position at which a top surface of the rubber suction cup 41 on the rotating disk 40 is lower than a lower surface of the compensating disk 52 and is separated a distance from the lower surface. The distance is a safe space along the vertical direction between the rubber suction cup 41 and the compensating disk 52.

Step S16: the lifting shaft 20 drives the rotating disk 40 to ascend to the handover operation station, the warped wafer 90 is handed over to the rotating disk 40 from the compensating disk 52, and the lifting shaft 20 drives the rotating disk 40 to continue to ascend to a pre-alignment operation position.

20 In one embodiment, after the lifting shaft 20 drives the rotating disk 40 to ascend to the handover operation position, the compensating disk 52 is not provided with the vacuum, and the small rubber suction cup 53 releases the warped wafer 90. The rotating disk 40 is provided with the vacuum, the rubber suction disk 41 adsorbs the warped wafer 90, and the warped wafer 90 is handed over to the rotating disk 40 from the compensating disk 52.

25 Step S17: the planarization treatment is executed, and the planarization treatment is performed on the edge of the warped wafer 90.

30 Step S18: the rotating shaft 30 drives the rotating disk 40 to rotate, the roller assembly 80 supports the warped wafer 90 when the rotating shaft 30 rotates, and the optomechanical assembly 60 collects the notch information of the warped wafer and the edge information of the warped wafer, and sends the collected notch information of the warped wafer and the collected edge information of the warped wafer to the controller.

Step S19: the controller calculates an eccentricity allowance of the warped wafer based on the notch information of the warped wafer and the edge information of the warped wafer. When the eccentricity allowance of the warped wafer satisfies a preset condition, the rotating shaft 30 is

rotated to cause the notch of the warped wafer 90 to rotate to a lower side of the optomechanical assembly 60.

In one embodiment, when the eccentricity allowance of the warped wafer 90 satisfies the preset condition, the center of the warped wafer 90 is determined, and the notch of the warped wafer 90 is rotated to the lower side of the optomechanical assembly 60 to execute step S20. When the eccentricity allowance does not satisfy the preset condition, step S12 to step S18 are repeated until the eccentricity allowance of the warped wafer 90 satisfies the preset condition.

Step S20: the rotating shaft 40 rotates back and forth by a small angle. The optomechanical assembly 60 collects the notch information of the warped wafer and sends the collected notch information of the warped wafer to the controller. The controller calculates a notch position error of the warped wafer based on the notch information of the warped wafer. The rotating shaft 40 is rotated to compensate the notch position error, to finish the orientating of the warped wafer 90.

In one embodiment, the pre-alignment method for the warped wafer further includes that, before step S12 and step S17, the roller assembly 80 ascends to the high position to support the warped wafer 90. In one embodiment, when the warped wafer 90 is adsorbed and positioned by the rotating disk 40, the lifting driving member 84 drives the roller supporting member 81 of the roller assembly to move upward, and the roller assembly 80 ascends to the high position. The supporting roller 82 supports the warped wafer 90. In another embodiment, the method further include that, before step S14, the roller assembly 90 descends to the low position. In another embodiment, before the warped wafer 90 is handed over to the compensating disk 52 from the rotating disk 40, the lifting driving member 84 is firstly started to drive the roller supporting member 81 to move upward, so that the spherical top surface of the supporting roller 82 is located below the handover surface of the compensating disk 52, so as to realize the switch of the roller assembly 80 from the high position to the low position, and avoid the situation that the warped wafer 90 is interfered with the roller assembly 80 when the warped wafer 90 is handed over to the compensating disk 52 from the rotating disk 40.

In one embodiment, the method further includes that, before step S11, the switching shaft 100 is adjusted based on the size of the warped wafer 90, and the optomechanical assembly 60 is adjusted to be on an operation position corresponding to the size of the warped wafer 90. In another embodiment, before the rotating disk 40 receives the warped wafer 90, the switching shaft 100 is firstly adjusted based on the size of the warped wafer 90, and the optomechanical assembly 60 is adjusted to be on the operation position corresponding to the size of the warped wafer 90.

Through performing the planarization treatment on the large warped wafer, the pre-alignment apparatus for the warped wafer can realize the adsorption positioning and planarization treatment on the large warped wafer, meet the pre-alignment positioning requirements for the large warped wafer, and improve the pre-alignment precision of the large warped wafer. The pre-alignment method for the warped wafer can perform the adsorption positioning and planarization treatment on the large warped wafer, and improve the pre-alignment precision of the large warped wafer.

Each of the technical features of the foregoing embodiments can be arbitrarily combined. For brevity of description, not all possible combinations of the technical features of the foregoing embodiments are described. However, as long as there is no conflict, all the combinations of the technical features should be considered as the scope of recited in the present description.

The foregoing embodiments are merely illustrative of the several embodiments of the present disclosure, which are described specifically and in detail, but are not intended to limit the scope of the present disclosure. It is to be understood that various of variants and improvement can be made to one skilled in the art without departing from the conception of the present disclosure, and be within the protection scope of the present disclosure. Therefore, the protection scope of the present disclosure is defined by the appended claims.

What is claimed is

1. A pre-alignment apparatus for a warped wafer, comprising: a bottom plate (10), a lifting shaft (20), a rotating shaft (30), a rotating disk (40), a compensating disk assembly (50), and an optomechanical assembly (60), wherein the lifting shaft (20), the compensating disk assembly (50) and the optomechanical assembly (60) are arranged on the bottom plate (10), the rotating shaft (30) is connected to the lifting shaft (20), the rotating disk (40) is connected to the rotating shaft (30);
- further comprising:
- an air nozzle assembly (70), configured to blow air to an edge of one side of a warped wafer (90), and apply pressure to the edge of the warped wafer (90), so as to planarize a region of the edge of the warped wafer (90); and
- a roller assembly (80), arranged corresponding to the air nozzle assembly (70) along a vertical direction, and configured to, in condition that the air nozzle assembly (70) blows the air to the warped wafer (90), support the edge of the warped wafer (90) on another side of the warped wafer (90),
- wherein the air nozzle assembly (70) and the roller assembly (80) are arranged on an optomechanical bracket (61) of the optomechanical assembly (60).
2. The pre-alignment apparatus for the warped wafer according to claim 1, wherein
- the air nozzle assembly (70) comprises an air nozzle supporting member (710) and an air nozzle; the air nozzle supporting member (71) is connected to the optomechanical bracket (61), and the air nozzle is mounted on the air nozzle supporting member (71); and
- the roller assembly (80) comprises a roller supporting member (81) and a supporting roller (82); the roller supporting member (81) is connected to the optomechanical bracket (61), the supporting roller (82) is mounted on the roller supporting member (81), and a spherical top surface of the supporting roller (82) is arranged opposite to an air outlet of the air nozzle.
3. The pre-alignment apparatus for the warped wafer according to claim 2, wherein the air nozzle assembly (70) comprises a plurality of air nozzles; the plurality of air nozzles are distributed in a circular arc shape on the air nozzle supporting member (71), and a distribution circle in which the plurality of air nozzles are located is concentric with the rotating disk (40).
4. The pre-alignment apparatus for the warped wafer according to claim 3, wherein distances from air outlet surfaces of the plurality of air nozzles to a rotating disk warped wafer rigid supporting surface (110) are different; in condition that one air nozzle is nearer to the optomechanical bracket

(61) than another air nozzle, a distance from an air outlet surface of the one air nozzle to the rotating disk warped wafer rigid supporting surface (110) is less than a distance from an air outlet surface of the another air nozzle to the rotating disk warped wafer rigid supporting surface (110).

5 5. The pre-alignment apparatus for the warped wafer according to claim 3 or 4, wherein the supporting roller (82) and one of the plurality of air nozzles closest to the optomechanical bracket (61) are coaxially arranged along the vertical direction; in condition that the one of the plurality of air nozzles blows the air to the warped wafer (90), the spherical top surface of the supporting roller (82) and the rotating disk warped wafer rigid supporting surface (110) are located on a same plane.

10 6. The pre-alignment apparatus for the warped wafer according to claim 5, wherein the roller assembly (80) further comprises a plurality of auxiliary rollers (83); the plurality of auxiliary rollers (83) are arranged corresponding to other air nozzle other than the one of the plurality of air nozzles closest to the optomechanical bracket (61), respectively; each of the other air nozzles and a corresponding auxiliary roller (83) are coaxially arranged along the vertical direction; and

15 a spherical top surface of a respective auxiliary rollers (83) is not coplanar with the spherical top surface of the supporting roller (82), and in condition that one auxiliary roller (83) is nearer to the supporting roller (82) than another auxiliary roller (83), a distance from a spherical top surface of the one auxiliary roller (83) to the rotating disk warped wafer rigid supporting surface (110) is greater than a distance from a spherical top surface of the another auxiliary roller (83) to the
20 rotating disk warped wafer rigid supporting surface (110).

7. The pre-alignment apparatus for the warped wafer according to any one of claims 2 to 4, wherein the roller supporting member (81) and the air nozzle supporting member (71) are both provided with a light passing hole.

25 8. The pre-alignment apparatus for the warped wafer according to any one of claims 1 to 3, wherein the roller assembly (80) further comprises a lifting driving member (84); the lifting driving member (84) is connected to the optomechanical bracket (61) and the roller supporting member (81) respectively.

30 9. The pre-alignment apparatus for the warped wafer according to any one of claims 1 to 4, further comprising a switching shaft (100), wherein the switching shaft (100) is arranged between the bottom plate (10) and the optomechanical assembly (60).

10. A pre-alignment method for a warped wafer, comprising:

receiving a warped wafer (90) by a rotating disk (40);

providing a positive pressure to an air nozzle assembly (70) and blowing air to an edge of one

side of the warped wafer (90) by the air nozzle assembly (70), so as to planarize a region of the edge of the warped wafer (90);

supporting the warped wafer (90) by a roller assembly (80) on another side of the warped wafer (90);

5 executing planarization treatment;

driving the rotating disk (40) by a rotating shaft (30) to continuously rotate for one revolution, supporting the warped wafer (90) by the roller assembly (80) when the rotating shaft (30) rotates, and collecting edge information of the warped wafer (90) by an optomechanical assembly (60) when the rotating shaft (30) rotates and sending the collected edge information of the warped
10 wafer (90) by the optomechanical assembly (60) to a controller to calculate an eccentricity;

driving the rotating disk (40) by a lifting shaft (20) to descend to a handover operation position, handing over the warped wafer (90) to a compensating disk (52) from the rotating disk (40);

driving the rotating disk (40) by the lifting shaft (20) to continue to descend to a handover low position, and moving a compensating shaft (51) to compensate the eccentricity of the warped
15 wafer (90);

driving the rotating disk (40) by the lifting shaft (20) to ascend to the handover operation position, handing over the warped wafer (90) to the rotating disk (40) from the compensating disk (52), and driving the rotating disk (40) by the lifting shaft (20) to continue to ascend to a pre-alignment operation position;

20 providing the positive pressure to the air nozzle assembly (70) and blowing the air to the edge of the one side of the warped wafer (90) by the air nozzle assembly (70), so as to planarize the region of the edge of the warped wafer (90);

supporting the warped wafer (90) by the roller assembly (80) on the other side of the warped wafer (90);

25 driving the rotating disk (40) by the rotating shaft (30) to rotate, supporting the warped wafer (90) by the roller assembly (80) when the rotating shaft (30) rotates, and collecting by the optomechanical assembly (60) notch information of the warped wafer (90) and the edge information of the warped wafer (90) and sending by the optomechanical assembly (60) the collected notch information of the warped wafer (90) and the collected edge information of the
30 warped wafer (90) to the controller;

calculating by the controller an eccentricity allowance of the warped wafer (90) based on the collected notch information of the warped wafer (90) and the collected edge information of the warped wafer (90), when the eccentricity allowance of the warped wafer (90) satisfies a preset

condition, rotating by the rotating shaft (30) a notch of the warped wafer (90) to a lower side of the optomechanical assembly (60); and

rotating the rotating shaft (30) back and forth by a small angle, collecting by the optomechanical assembly (60) the notch information of warped wafer (90) and sending by the optomechanical assembly (60) the notch information of warped wafer (90) to the controller, calculating by the controller a notch position error of the warped wafer (90) based on the notch information of the warped wafer (90), rotating the rotating shaft (30) to compensate the notch position error, and finishing orientating of the warped wafer (90).

11. The pre-alignment method for the warped wafer according to claim 10, further comprising:

before the executing the planarization treatment, ascending the roller assembly (80) to a high position and supporting warped wafer (90) by the roller assembly (80); and

before the driving the rotating disk (40) by the lifting shaft (20) to descend to the handover operation position, and handing over the warped wafer (90) to the compensating disk (52) from the rotating disk (40), descending the roller assembly to a low position.

12. The pre-alignment method for the warped wafer according to claim 10, further comprising:

before the receiving the warped wafer (90) by the rotating disk (40), adjusting a switching shaft based on a size of the warped wafer (90), and adjusting the optomechanical assembly (60) to be on an operation position corresponding to the size of the warped wafer (90).