A wafer-transfer device for a chemical-mechanical polishing apparatus includes a base and lifting frame. A first cylinder is connected to a lower portion of the lifting frame to lift it and includes a piston rod passing through the lower portion of the lifting frame and fixed to the base. A basin-shaped contraposition ring is mounted onto an upper portion of the lifting frame via a spring. An inner edge of a top of the contraposition ring defines a curved surface adapted to a contour of a polishing head of the chemical-mechanical polishing apparatus. A wafer support is disposed above the contraposition ring. A second cylinder is mounted onto the contraposition ring and includes a piston rod passing through the contraposition ring and connected to a bottom of the wafer support to lift it. Respective axes of the wafer support, second cylinder, and contraposition ring coincide with one another.
WAFER TRANSFER DEVICE FOR CHEMICAL MECHANICAL POLISHING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a “national phase” application of Patent Cooperation Treaty Application PCT/CN2011/076831 filed on Jul. 4, 2011, which, in turn, claims priority to and benefit of the filing date of Chinese Patent Application 201010623316.8 filed on Dec. 29, 2010 and entitled “Wafer Transfer Device for Chemical Mechanical Polishing Apparatus.”

BACKGROUND OF INVENTION

[0002] 1. Field of Invention
[0003] The invention relates, generally, to a wafer-transfer device and, more specifically, to such a device for a chemical-mechanical polishing apparatus.

[0004] 2. Description of Related Art
[0005] A wafer-transfer device needs to be used for transferring and positioning a wafer during a chemical-mechanical polishing process. Accurate docking between a conventional wafer-transfer device and polishing head is difficult to realize because of mechanical errors, which may cause failures of wafer transfer (particularly when the wafer is loaded by the polishing head) or even result in wafer breakage, thus seriously affecting the subsequent operation.

[0006] Thus, there is a need in the related art for a wafer-transfer device for transferring and positioning a wafer during a chemical-mechanical polishing process that may be accurately docked with a polishing head. More specifically, there is a need in the related art for such a device accurate docking between it and a polishing head is not difficult to realize because of mechanical error. There is a need in the related art for such a device that also does not cause failures of wafer transfer, particularly when the wafer is loaded by the polishing head. There is a need in the related art for such a device that also does not even result in wafer breakage, thus seriously affecting the subsequent operation.

SUMMARY OF INVENTION

[0007] The invention overcomes the disadvantages in the related art in a wafer-transfer device for a chemical-mechanical polishing apparatus. The device includes a base and lifting frame. A first cylinder is connected to a lower portion of the lifting frame to lift the lifting frame and has a piston rod passing through the lower portion of the lifting frame and fixed to the base. A basin-shaped contraposition ring is mounted onto an upper portion of the lifting frame via a spring. An inner edge of the top of the contraposition ring has a curved surface adapted to a contour of a polishing head of the chemical-mechanical polishing apparatus. A wafer support is disposed above the contraposition ring. A second cylinder is mounted onto the contraposition ring and has a piston rod passing through the contraposition ring and connected to a bottom of the wafer support to lift the wafer support. An axis of the wafer support, an axis of the second cylinder, and an axis of the contraposition ring coincide with one another.

[0008] An advantage of the wafer-transfer device of the invention is that it transfers and positions a wafer during a chemical-mechanical polishing process and may be accurately docked with a polishing head.

[0009] Another advantage of the wafer-transfer device of the invention is that accurate docking between it and a polishing head is not difficult to realize because of mechanical error.

[0010] Another advantage of the wafer-transfer device of the invention is that it does not cause failures of wafer transfer, particularly when the wafer is loaded by the polishing head.

[0011] Another advantage of the wafer-transfer device of the invention is that it does not even result in wafer breakage, thus seriously affecting the subsequent operation.

[0012] Other objects, features, and advantages of the invention are readily appreciated as the same becomes better understood while the subsequent detailed description of embodiments of the invention is read taken in conjunction with the accompanying drawing thereof.

BRIEF DESCRIPTION OF EACH FIGURE OF DRAWING OF INVENTION

[0013] FIG. 1 is a sectional view of an embodiment of a wafer-transfer device for a chemical-mechanical polishing apparatus according to the invention;

[0014] FIG. 2 is a sectional view showing the embodiment of the wafer-transfer device for a chemical-mechanical polishing apparatus according to the invention shown in FIG. 1 docked with a polishing head; and

[0015] FIG. 3 is a sectional view showing a wafer ejected from the embodiment of the wafer-transfer device for a chemical-mechanical polishing apparatus according to the invention shown in FIG. 1.

DETAILED DESCRIPTION OF EMBODIMENTS OF INVENTION

[0016] Referring now to the figures, where like numerals are used to represent like structure, an embodiment of a wafer-transfer device for a chemical-mechanical polishing apparatus according to the invention is generally indicated at 10. The wafer-transfer device 10 includes generally a base 100, a lifting frame 200, a first cylinder 300, a basin-shaped contraposition ring 400, a wafer support 500, and a second cylinder 600.

[0017] The first cylinder 300 is connected to a lower portion 240 of the lifting frame 200 to lift the lifting frame 200. A piston rod 310 of the first cylinder 300 passes through the lower portion 240 of the lifting frame 200 and is fixed to the base 100. The contraposition ring 400 is mounted onto an upper portion 230 of the lifting frame 200 via a spring 410, and an inner edge of the top of the contraposition ring 400 has a curved surface adapted to a contour of a polishing head 30 of the chemical-mechanical polishing apparatus. The wafer support 500 is disposed above the contraposition ring 400. The second cylinder 600 is mounted onto the contraposition ring 400. A piston rod 610 of the second cylinder 600 passes through the contraposition ring 400 and is connected to a bottom of the wafer support 500 to lift the wafer support 500. An axis of the wafer support 500, an axis of the second cylinder 600, and an axis of the contraposition ring 400 are coincided with one another.

[0018] With the wafer-transfer device 10, because the inner edge of the top of the contraposition ring 400 has the curved surface adapted to the contour of the polishing head 30 of the chemical-mechanical polishing apparatus, when the polishing head 30 carrying a wafer 20 is docked with the wafer-transfer device 10, the curved surface of the curved surface of
the top of the contraposition ring 400 may be coincided with the contour of the polishing head 30 so that the contraposition ring 400 may be accurately docked with the polishing head 30 under an action of geometrical factors. Therefore, the wafer-transfer device 10 may significantly increase the success rate of the wafer transfer so that the efficiency of the chemical-mechanical polishing is improved greatly and the cost of the chemical-mechanical polishing is remarkably lowered.

[0019] Referring to FIGS. 1 through 3, in an embodiment, the upper portion 230 of the lifting frame 200 may be formed with a side wall 210 surrounding the contraposition ring 400 and being perpendicular to the lifting frame 200. The contraposition ring 400 may be surrounded inside the side wall 210, thus protecting the contraposition ring 400. Specifically, the side wall 210 may be integrally formed with the lifting frame 200.

[0020] In an embodiment, the wafer-transfer device 10 may include further a guiding shaft 700 and linear bearing 800. A first end of the guiding shaft 700 may be fixed to the base 100, and a second end of the guiding shaft 700 may pass through the lower portion 240 of the lifting frame 200. The linear bearing 800 may be fitted over the guiding shaft 700 and fixed to the lower portion 240 of the lifting frame 200. An axis of the linear bearing 800 is parallel to the axis of the wafer support 500. By providing the guiding shaft 700 and linear bearing 800, the lifting frame 200 may be driven by the first cylinder 300 to lift along the axis of the guiding shaft 700. That is, the lifting frame 200 may be driven by the first cylinder 300 to lift along the axis of the wafer support 500 so that the wafer support 500 is always maintained in a "horizontal" state.

[0021] Specifically, a plurality of first cylinders 300 are arranged on the lower portion 240 of the lifting frame 200 along a circumferential direction of the lifting frame 200 at equal intervals. That is, the plurality of first cylinders 300 may be located on one circumference. By arranging a plurality of first cylinders 300 on the lower portion 240 of the lifting frame 200 along the circumferential direction of the lifting frame 200 at equal intervals, when the lifting frame 200 is driven by the first cylinders 300 to lift, a driving force of the first cylinders 300 may be balanced and uniformly applied to the lifting frame 200 to avoid unbalanced loading. Alternatively, a plurality of linear bearings 800 are arranged on the lower portion 240 of the lifting frame 200 along the circumferential direction of the lifting frame 200 at equal intervals. That is, the plurality of linear bearings 800 may be located on one circumference. A plurality of guiding shafts 700 may be arranged on the lower portion 240 of the lifting frame 200 along the circumferential direction of the lifting frame 200 at equal intervals. That is, the plurality of guiding shafts 700 may be located on one circumference. By arranging the plurality of guiding shafts 700 and plurality of linear bearings 800 on the lower portion 240 of the lifting frame 200 along the circumferential direction of the lifting frame 200 at equal intervals, the lifting frame 200 may be driven by the first cylinders 300 to accurately lift along the axis of the wafer support 500 so that the wafer support 500 is always maintained in a "horizontal" state.

[0022] In an embodiment, the wafer-transfer device 10 may include further a screw 420, which may pass through a through-hole 430 formed in the contraposition ring 400 and spring 410 and be screwed into a screw-hole formed in the upper portion 230 of the lifting frame 200. In other words, the screw 420 passes through the through-hole 430, spring 410, and screw-hole 420 in sequence from top to bottom. The contraposition ring 400 may be firmly mounted onto the upper portion 230 of the lifting frame 200 by the screw 420.

[0023] In an embodiment, the through-hole 430 may include a large aperture portion 431 and small aperture portion 432 located below and communicate with the large aperture portion 431. The screw 420 may include a screw cap 421 and screw stem 422 connected with each other. The screw cap 421 may be received inside the large aperture portion 431 and cover a top of the small aperture portion 432. The screw stem 422 may pass through the small aperture portion 432, spring 410, and screw-hole in sequence from top to bottom. By receiving the screw cap 421 inside the large aperture portion 431 of the through-hole 430, the screw 420 may be protected, and the structure of the wafer-transfer device 10 may be simplified. Specifically, a diameter of the screw stem 422 of the screw 420 may be smaller than that of the small aperture portion 432 of the through-hole 430 by 1-3 mm, which may allow the contraposition ring 400 to move horizontally in a predetermined range when an outside force is applied to the contraposition ring 400.

[0024] In an embodiment, the wafer-transfer device 10 may include further a cover plate 440 for covering a top of the through-hole 430 in the contraposition ring 400. In other words, the cover plate 440 may cover a top of the large aperture portion 431 of the through-hole 430 in the contraposition ring 400. The cover plate 440 may prevent foreign matter from entering into the through-hole 430. Specifically, the cover plate 440 may be disposed in a step-slot formed in the top of the through-hole 430 (i.e., the top of the large aperture portion 431).

[0025] In an embodiment, a plurality of screws 420, plurality of cover plates 440, and plurality of springs 410 are arranged on the upper portion 230 of the lifting frame 200 along a circumferential direction of the lifting frame 200 at equal intervals, respectively. When the amounts of compression of the plurality of springs 410 are different, the contraposition ring 400 may deflect in a small range. Specifically, the plurality of screws 420, plurality of cover plates 440, and plurality of springs 410 may be arranged on one circumference.

[0026] In an embodiment, the wafer-transfer device 10 may include further a hydraulic buffer 900 mounted onto the lower portion 240 of the lifting frame 200 and located below the base 100. During an ascending process of the lifting frame 200, when the lifting frame 200 nearly approaches an end of the ascending travel (for instance, when a distance from the lifting frame 200 to the end of the ascending travel is 3-5 mm), the hydraulic buffer 900 may be contacted with the base 100 so that a reacting force may be applied to the lifting frame 200 by the base 100 to reduce the ascending speed of the lifting frame 200. Therefore, the contraposition ring 400 may be prevented from crashing into the polishing head 30 to ensure a successful docking of the contraposition ring 400 with the polishing head 30. Specifically, an external screw thread is formed on the hydraulic buffer 900, and an internal screw thread is formed on the lower portion 240 of the lifting frame 200 so that the hydraulic buffer 900 may be threadedly fitted in the lower portion 240 of the lifting frame 200 or locked in the lower portion 240 of the lifting frame 200 via a screw nut.

[0027] In an embodiment, a plurality of hydraulic buffers 900 are arranged on the lower portion 240 of the lifting frame 200 along a circumferential direction of the lifting frame 200 at equal intervals (that is, the plurality of hydraulic buffers 900 are located on one circumference) so that the reacting
force applied to the lifting frame 200 by the base 100 is uniformly distributed onto the lifting frame 200.

[0028] In an embodiment, a chamber 220 may be defined in the lifting frame 200, and a portion of the second cylinder 600 is located in the chamber 220 so that the space occupied by the wafer-transfer device 10 is greatly saved and the structure of the wafer-transfer device 10 is compact. Specifically, the lifting frame 200 may be hollow and I-shaped. That is, both of the upper portion 230 and lower portion 240 of the lifting frame 200 may be rounded while a middle portion 250 of the lifting frame 200 may be hollow and have a cylindrical cross-section. The middle portion 250 of the lifting frame 200 may be connected with the upper portion 230 and lower portion 240 of the lifting frame 200, respectively.

[0029] A wafer-transfer process of the wafer-transfer device 10 will now be described. FIG. 1 shows an “initial” state of the wafer-transfer device 10, wherein each part of the wafer-transfer device 10 is at a “low” position. When the polishing head 30 is moved above the wafer-transfer device 10, the first cylinder 310 is actuated (that is, the piston rod 310 of the first cylinder 300 is retracted into a chamber of the first cylinder 300) to drive the lifting frame 200 to move upward and then to drive the contraposition ring 400 and wafer support 500 to move upward until the contraposition ring 400 is locked with the polishing head 30 (as shown in FIG. 2). Then, the wafer 20 is released by the polishing head 30 and drops onto the wafer support 500 under the action of its gravity. Then, the polishing head 30 leaves. Subsequently, the first cylinder 300 is actuated (that is, the piston rod 310 of the first cylinder 300 is extended out of the chamber of the first cylinder 300) to drive the lifting frame 200 to move downward and then to drive the contraposition ring 400 and wafer support 500 to move downward until each of the lifting frame 200, contraposition ring 400, and wafer support 500 goes back to an “initial” position (the “low” position). Thus, an unloading of the wafer 20 is completed. Subsequently, the second cylinder 600 is actuated (that is, the piston rod 610 of the second cylinder 600 is extended out of the chamber of the second cylinder 600) to drive the wafer support 500 and wafer 20 on the wafer support 500 to move upward (as shown in FIG. 3) so that the wafer 20 on the wafer support 500 may be taken away by a robot. Finally, the second cylinder 600 is actuated (that is, the piston rod 610 of the second cylinder 600 is retracted into the chamber of the second cylinder 600) to drive the wafer support 500 to move downward until the wafer support 500 goes back to an “initial” position (the “low” position).

[0030] A process of transferring the wafer 20 to the wafer-transfer device 10 by the robot and then loading the wafer 20 onto the polishing head 30 is contrary to the foregoing process so that the detailed description thereof is omitted here. With the wafer-transfer device 10, the contraposition ring 400 may be accurately docked with the polishing head 30.

[0031] The wafer-transfer device 10 transfers and positions wafer during a chemical-mechanical polishing process and may be accurately docked with a polishing head. Also, accurate docking between the wafer-transfer device 10 and a polishing head is not difficult to realize because of mechanical error. Furthermore, the wafer-transfer device 10 does not cause failures of wafer transfer, particularly when the wafer is loaded by the polishing head. In addition, the wafer-transfer device 10 does not even result in wafer breakage, thus seriously affecting the subsequent operation.

[0032] The invention has been described above in an illustrative manner. It is to be understood that the terminology that has been used above is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the invention may be practiced other than as specifically described above.

What is claimed is:

1. A wafer-transfer device for a chemical-mechanical polishing apparatus, said device comprising:
a base;
a lifting frame;
at least one first cylinder connected to a lower portion of said lifting frame to lift said lifting frame and including a piston rod passing through said lower portion of said lifting frame and fixed to said base;
a basin-shaped contraposition ring mounted onto an upper portion of said lifting frame via at least one spring, an inner edge of a top of said contraposition ring defining a curved surface adapted to a contour of a polishing head of the chemical-mechanical polishing apparatus;
a wafer support disposed above said contraposition ring;
and
a second cylinder mounted onto said contraposition ring and including a piston rod passing through said contraposition ring and connected to a bottom of said wafer support to lift said wafer support, wherein an axis of said wafer support, an axis of said second cylinder, and an axis of said contraposition ring coincide with one another.

2. A wafer-transfer device as set forth in claim 1, wherein said upper portion of said lifting frame is formed with a side wall surrounding said contraposition ring and being substantially perpendicular to said upper portion of said lifting frame.

3. A wafer-transfer device as set forth in claim 1, wherein said device comprises further at least one guiding shaft including a first end fixed to said base and a second end passing through said lower portion of said lifting frame and at least one linear bearing fitted over said guiding shaft, fixed to said lower portion of said lifting frame, and defining an axis of said linear bearing that is substantially parallel to said axis of said wafer support.

4. A wafer-transfer device as set forth in claim 1, wherein said device comprises further at least one screw that passes through a corresponding through-hole formed in said contraposition ring and spring and is screwed into a corresponding screw-hole formed in said upper portion of said lifting frame.

5. A wafer-transfer device as set forth in claim 4, wherein said device comprises further at least one cover plate for covering a top of corresponding said through-hole in said contraposition ring.

6. A wafer-transfer device as set forth in claim 5, wherein a plurality of screws, cover plates, and springs are arranged on said upper portion of said lifting frame along a circumferential direction of said lifting frame at substantially equal respective intervals.

7. A wafer-transfer device as set forth in claim 1, wherein said device comprises further a plurality of hydraulic buffers mounted onto said lower portion of said lifting frame, arranged on said lower portion of said lifting frame along a circumferential direction of said lifting frame at substantially equal intervals, and located below said base.
8. A wafer-transfer device as set forth in claim 1, wherein a chamber is defined in said lifting frame and a portion of said second cylinder is located in said chamber.

9. A wafer-transfer device as set forth in claim 3, wherein a plurality of first cylinders are arranged on said lower portion of said lifting frame along a circumferential direction of said lifting frame at substantially equal intervals and a plurality of linear bearings and guiding shafts are arranged on said lower portion of said lifting frame along said circumferential direction at substantially equal respective intervals.

10. A wafer-transfer device as set forth in claim 1, wherein said lifting frame is substantially hollow and l-shaped.

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