

SUBSTRATE BEARING DEVICE AND SUBSTRATE PROCESSING

APPARATUS

FIELD OF THE INVENTION

The present application relates to the field of semiconductor equipment, and in particular, to a substrate bearing device and a substrate processing apparatus.

BACKGROUND

Semiconductor cleaning is an important process step throughout the entire wafer manufacturing process, and the quality of the cleaning process is the key to improving the yield. The tank-type cleaning equipment is used for batch wafer wet cleaning and has high production efficiency. During the cleaning process, the fluid distribution in a process tank has a great influence on the cleaning effect, and the fluid distribution is closely related to the internal structure of the process tank.

In tank-type cleaning processes, wafer sets are borne by parallel, equally spaced slots arrayed on a substrate bearing device and placed into a process tank for cleaning with a processing solution. In practical applications, it is commonly observed that the first wafer close to the vertical sidewall of the substrate bearing device exhibits a poor cleaning effect compared to other wafers in the same set.

SUMMARY

The technical problem to be solved by the present invention is to overcome the problem of poor cleaning effect of the first wafer close to the vertical sidewall of the substrate bearing device in the prior art. The present invention provides a substrate bearing device and a substrate processing apparatus.

The present invention solves the above technical problem through the following technical solutions.

The present invention provides a substrate bearing device, comprising:

a connecting member, including a connecting main body extending in the vertical

direction;

a bearing member, connected to the connecting member, extending in the horizontal direction, and bearing a plurality of substrates in a manner that the plurality of substrates are parallel to the vertical direction, the plurality of substrates including a first substrate adjacent to a major surface of the connecting member;

wherein the connecting member further includes a flow rectifying portion, a major surface of the flow rectifying portion is flush with a major surface of the connecting main body, and the flow rectifying portion is configured such that when the bearing member bears the substrates, the orthographic projection of the first substrate on the flow rectifying portion is located inside the flow rectifying portion.

A substrate processing apparatus, comprising:

a processing tank, for containing processing liquid;

the above-mentioned substrate bearing device, arranged inside the processing tank;

a bubbler, arranged in the processing tank and located below the bearing member, for supplying bubbles into the processing liquid.

The positive and progressive effects of the present invention are as follows:

1. In the present invention, by adding a flow rectifying portion corresponding to the first substrate on the connecting member and making the orthographic projection of the first substrate on the flow rectifying portion locate inside the flow rectifying portion, the flow field on the side of the first substrate close to the flow rectifying portion is greatly improved and can be similar to the flow field between other substrates, thereby enhancing the cleaning effect of the first substrate. The major surface of the flow rectifying portion is flush with the major surface of the connecting main body; in one aspect, the flow rectifying portion does not occupy additional space in the horizontal direction; in another aspect, the major surface of the connecting member has no protrusions or depressions, so that the flow field is more stable during the cleaning process, which is conducive to further improving the cleaning effect. In addition, the

addition of the flow rectifying portion also helps to improve the strength of the connecting member, making the connecting member less prone to deformation.

2. The bubbler is arranged in the processing tank and located below the bearing member for supplying bubbles into the processing liquid. Under the action of the bubbler, the processing liquid in the processing tank flows rapidly; with the above-mentioned substrate bearing device adopted, the flow field at the first substrate is basically consistent with the flow field between adjacent substrates, and the cleaning effect of the first substrate is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present application are further described by the following embodiments and the accompanying drawings of the embodiments.

FIG. 1 is a schematic axonometric structural view of the substrate bearing device according to Embodiment 1 of the present invention;

FIG. 2 is a schematic structural view of the substrate bearing device according to Embodiment 1 of the present invention in a state of bearing substrates;

FIG. 3 is a schematic front structural view of the substrate bearing device according to Embodiment 1 of the present invention;

FIG. 4 is a schematic front structural view of the connecting member according to Embodiment 1 of the present invention;

FIG. 5 is a schematic internal structural view of the substrate processing apparatus according to Embodiment 2 of the present invention;

FIG. 6 is a schematic axonometric structural view of the substrate processing apparatus according to Embodiment 2 of the present invention;

FIG. 7 is a schematic top structural view of the substrate processing apparatus according to Embodiment 2 of the present invention;

FIG. 8 is a schematic structural view of the bubbler according to Embodiment 2

of the present invention;

FIG. 9 is a schematic structural view of the bubbler and the substrate according to Embodiment 2 of the present invention;

FIG. 10 is a schematic structural view of the bubbler according to Embodiment 3 of the present invention.

EMBODIMENTS OF THE INVENTION

The present invention is further illustrated by the following embodiments, but the present invention is not limited to the scope of the embodiments.

Embodiment 1

As shown in FIGS. 1 and 2, a substrate bearing device is provided in Embodiment 1 of the present invention, which comprises a connecting member 100 and a bearing member 200. The connecting member 100 includes a connecting main body 120 extending in the vertical direction Z. The bearing member 200 is connected to the lower part of the connecting member 100 and bears a plurality of substrates 300 in a manner that the plurality of substrates 300 are parallel to the vertical direction Z. Wherein, the plurality of substrates 300 include a first substrate 310 adjacent to a major surface of the connecting member 100. Wherein, the connecting member 100 further includes a flow rectifying portion 110, and a major surface of the flow rectifying portion 110 is flush with a major surface of the connecting main body 120. The flow rectifying portion 110 is configured such that when the bearing member 200 bears the substrates, the orthographic projection of the first substrate 310 on the flow rectifying portion 110 is located inside the flow rectifying portion 110.

Since the existing connecting member is not provided with the flow rectifying portion, the flow field where the first substrate is located is relatively uneven compared to the flow field where other substrates are located, thus resulting in a poor cleaning effect of the first substrate. In the present invention, by adding the flow rectifying portion 110 corresponding to the first substrate 310 on the connecting member 100 and making the orthographic projection of the first substrate 310 on the flow rectifying portion 110 locate inside the flow rectifying portion 110, the flow field on the side of

the first substrate 310 close to the flow rectifying portion 110 is greatly improved and can be similar to the flow field between other substrates 300, thereby enhancing the cleaning effect of the first substrate 310. The major surface of the flow rectifying portion 110 is flush with the major surface of the connecting main body 120; in one aspect, the flow rectifying portion 110 does not occupy additional space in the horizontal direction Y; in another aspect, the major surface of the connecting member 100 has no protrusions or depressions, so that the flow field is more stable during the cleaning process, which is conducive to further improving the cleaning effect. In addition, the addition of the flow rectifying portion 110 also helps to improve the strength of the connecting member 100, making the connecting member 100 less prone to deformation.

Wherein, the major surfaces of the flow rectifying portion, the connecting member, and the connecting main body respectively refer to the surfaces facing the first substrate.

In the embodiment of the present invention, in order to ensure that the flow field between the first substrate 310 and the connecting member 100 is as similar to the flow field between adjacent substrates 300 as possible, the spacing between the flow rectifying portion 110 and the first substrate 310 is set to be 1 time the spacing between adjacent substrates 300, and the shape of the flow rectifying portion 110 is the same as the shape of the first substrate 310. The plurality of substrates 300 include a second substrate adjacent to the first substrate 310, and the flow rectifying portion 110 and the second substrate are symmetrical about the first substrate 310, thereby ensuring that the flow field where the first substrate 310 is located is as similar to the flow field where other substrates 300 are located as possible, and improving the cleaning effect of the first substrate 310. It should be noted that the symmetry herein means that the distance between the flow rectifying portion 110 and the first substrate 310 is equal to the distance between the second substrate and the first substrate 310, and the flow rectifying portion 110 and the second substrate have the same shape and size.

Specifically, in this embodiment, the first substrate is circular in shape, and the flow rectifying portion is circular in shape correspondingly. In other embodiments, the shape of the first substrate can also be flexibly set as required, and the shape of the flow rectifying portion only needs to correspond to the shape of the first substrate.

In other embodiments, in order to facilitate taking out the substrates 300 from the substrate bearing device, the spacing between the flow rectifying portion 110 and the first substrate 310 can be appropriately increased to be in the range of 1 time to less than 2 times the spacing between adjacent substrates 300, which can also achieve the effect of improving the flow field.

In other embodiments, in order to adapt to a substrate picking device requiring a larger space, the spacing between the flow rectifying portion 110 and the first substrate 310 can be further increased to be in the range of 2 times to 3 times the spacing between adjacent substrates 300.

In the embodiment of the present invention, the structure of the bearing member 200 is as shown in FIG. 1. The bearing member 200 includes two first slots 210 located on the outside and one second slot 220 located in the middle. Both the first slots 210 and the second slot 220 are provided with loading grooves at equal intervals. Through the first slots 210 and the second slot 220, the plurality of substrates 300 can be arranged on the bearing member 200 at equal intervals. The space between the first slots 210 and the second slot 220 is of a hollow design, which is conducive to the circulation of a processing liquid.

Further, as shown in FIGS. 3 and 4, the connecting member 100 further includes a reinforcing portion 130, the reinforcing portion 130 is located below the flow rectifying portion 110, and the bearing member 200 is connected to the reinforcing portion 130. By arranging the reinforcing portion 130, the reliability of the connection between the connecting member 100 and the bearing member 200 can be enhanced, and the whole substrate bearing device is more stable.

In other embodiments, in order to further improve the consistency of the flow field between the first substrate 310 and the connecting member 100 with the flow field between adjacent substrates 300, the reinforcing portion 130 can also be removed, and the bearing member 200 is directly connected to the lower end of the flow rectifying portion 110. The bearing member 200 and the flow rectifying portion 110 can be connected by welding. In addition, the bearing member 200 can also be connected to both the flow rectifying portion 110 and the reinforcing portion 130 at the same time.

Since processing errors are inevitably generated in both the bearing member 200 and the flow rectifying portion 110, in order to prevent the orthographic projection of the first substrate 310 on the flow rectifying portion 110 from deviating from the flow rectifying portion 110, the area of the major surface of the flow rectifying portion 110 can be appropriately increased to be controlled in the range of 1 time to 1.01 times the area of the major surface of the first substrate 310, and the flow rectifying portion 110 is concentric with the orthographic projection of the first substrate 310 on the flow rectifying portion 110.

Embodiment 2

A substrate processing apparatus is provided in this embodiment, as shown in FIGS. 5 and 6, which comprises a processing tank 600, a bubbler 420, and the substrate bearing device in Embodiment 1. The processing tank 600 is used for containing a processing liquid for processing the plurality of substrates 300. The substrate bearing device is arranged in the processing tank 600 in a liftable manner, and the substrate bearing device can be connected to a lifting mechanism through an adapter portion 140, so as to realize the lifting function. The bubbler 420 is arranged in the processing tank 600 and located below the bearing member 200, for supplying bubbles into the processing liquid. Under the action of the bubbler 420, the processing liquid in the processing tank 600 flows rapidly; with the substrate bearing device in Embodiment 1 adopted, the flow field at the first substrate 310 is basically consistent with the flow field between adjacent substrates 300, and the cleaning effect of the first substrate 310 is improved.

In the embodiment of the present invention, as shown in FIG. 5, the flow rectifying portion 110 is configured to be formed on the connecting main body 120 of the connecting member 100 by means of additive manufacturing. Specifically, the flow rectifying portion 110 is formed by welding a corresponding plate-shaped structure on the edge of the connecting main body 120. This method can upgrade and transform the existing substrate bearing device, which is conducive to reducing the manufacturing cost.

In other embodiments, the flow rectifying portion 110 and the connecting main body 120 of the connecting member 100 can also be manufactured by an integral

molding process, which has higher processing precision.

According to FIGS. 5 and 7, the processing liquid in the processing tank 600 is supplied through a liquid inlet pipeline 510 and a processing liquid discharge portion 520. The liquid inlet pipeline 510 is used for supplying the processing liquid to the processing liquid discharge portion 520, the liquid inlet pipeline 510 is provided with a branch pipeline (not shown in the figure), and the branch pipeline is connected to an outer tank 610, so that the processing liquid circulates between an inner tank 620 and the outer tank 610. The processing liquid discharge portion 520 is located between the bubbler 420 and the plurality of substrates 300, the processing liquid discharge portion 520 extends along the Y direction, and the processing liquid discharge portion 520 is provided with a plurality of processing liquid discharge holes, for improving the fluidity of the processing liquid in the processing tank 600.

As shown in FIGS. 6 and 7, the processing tank 600 includes the inner tank 620 and the outer tank 610. The inner tank 620 is used for accommodating the substrate bearing device and storing the processing liquid submerging the plurality of substrates 300. The arrangement direction of the substrates 300 is defined as the Y direction, the horizontal direction parallel to the major surface of the substrates 300 is defined as the X direction, and the X direction and the Y direction are perpendicular to each other. The inner tank 620 includes two first side walls 623 oppositely arranged along the X direction and two second side walls 622 oppositely arranged along the Y direction. A plurality of overflow ports 621 are arranged on the two first side walls 623 at intervals, the lowest point of the overflow ports 621 is an overflow level, the overflow levels of the two first side walls 623 are lower than the top surfaces of the two second side walls 622, and the overflow levels are used for making the processing liquid overflow from the overflow levels of the two first side walls 623 into the outer tank 610.

Since the overflow levels of the two first side walls 623 are lower than the top surfaces of the two second side walls 622, the processing solution in the inner tank body 620 can only overflow into the outer tank 610 through the two first side walls 623. The overflow direction of the processing solution is parallel to the direction of the substrates 300, providing a certain scouring effect on the substrates 300, which is conducive to improving the cleaning effect of the substrates 300.

For the specific structure of the bubbler 420, refer to FIGS. 5 and 8. The bubbler 420 includes bubbling chambers 421 and a bubbling plate 422. The bubbling plate 422 faces the bearing member 200, and the bubbling plate 422 is provided with a plurality of openings 423. The bubbling chambers 421 are flat and used for supplying gas to the plurality of openings 423. The interior of each bubbling chamber 421 includes four mutually independent gas channels, and the gas supply flow rates of the four gas channels are independently controlled. The bubbling chambers 421 can be supplied with gas through gas inlet pipelines 410. In other embodiments, the internal division of the bubbling chambers 421 is not limited thereto, and at least two mutually independent gas channels can be arranged as required, and the gas supply flow rates of all gas channels are independently controlled.

The independent control of the gas supply flow rates of all gas channels is illustrated by the division mode of the bubbling chamber 421 shown in FIG. 9. The bubbling chamber 421 is divided into gas channels L1 to L4 along the X direction; similarly, the substrates 300 are divided into processing areas M1 to M4 in one-to-one correspondence with the gas channels L1 to L4 along the X direction. In this embodiment, by adjusting the gas flow rates of the gas channels to control the bubbling behavior in the corresponding processing regions, such as the bubble quantity, so as to make the processing rates in various processing regions on the substrates 300 identical, thereby improving the intra-substrate uniformity of the processing of the substrates 300. For example, when processing the substrates 300 under the condition of identical gas supply flow rates through gas channels L1 to L4, the average processing rates V1 to V4 are obtained for respective processing regions M1 to M4 of the substrates 300. When experimental results show that $V1 = V4 < V2 = V3$, the gas supply flow rates through gas channels L1 and L4 can be increased to increase the bubble quantity in processing regions M1 and M4, thereby enhancing the agitation effect and mass transfer efficiency in processing regions M1 and M4, further improving the processing rates in processing regions M1 and M4, and achieving $V1 = V2 = V3 = V4$, thus attaining the objective of improving the intra-substrate uniformity of the processing of the substrates 300. Furthermore, in combination with the substrate bearing device of Embodiment 1, the processing uniformity among different substrates 300 can also be improved.

Embodiment 3

The substrate processing apparatus in this embodiment is substantially identical to the substrate processing apparatus of Embodiment 2, with the difference being that, as shown in FIG. 10, in the present embodiment, a bubbler 720 includes four independently arranged bubbling units 7201, and each bubbling unit 7201 is connected to a gas inlet pipe 710 for independent gas supply. The top surface of each bubbling unit 7201 includes a plurality of openings, and the interior of each bubbling unit 7201 forms a bubbling chamber for supplying gas to the plurality of openings, wherein the bubbling chamber includes a single gas channel.

The bubbler 420 in Embodiment 2 is fabricated as an integral unit, whereas the bubbler 720 in the present embodiment is divided into multiple independent bubbling units 7201, and each bubbling unit 7201 has lower processing difficulty. When the bubbler 720 is fabricated, each bubbling unit 7201 can be processed individually, and the multiple bubbling units 7201 can be assembled together during use, which facilitates reducing the fabrication difficulty of the bubbler 720 and improving the yield rate of the bubbler 720. Moreover, since each bubbling unit 7201 is independent, a damaged bubbling unit 7201 can be replaced individually without replacing the entire bubbler 720, thereby reducing the replacement cost.

In other embodiments, the number of the bubbling units 7201 is not limited thereto, and at least two bubbling units 7201 can be arranged as required. In addition, the bubbling chamber formed inside each bubbling unit 7201 can also be provided with more than two gas channels, and the gas supply of all gas channels can be independently controlled.

Although the specific embodiments of the present invention have been described above, those skilled in the art should understand that these embodiments are only examples, and the protection scope of the present invention is defined by the appended claims. Those skilled in the art can make various changes or modifications to these embodiments without departing from the principle and essence of the present invention, and these changes and modifications all fall within the protection scope of the present invention.

What is claimed is:

1. A substrate bearing device, comprising:

a connecting member, including a connecting main body extending in the vertical direction;

a bearing member, connected to the connecting member, extending in the horizontal direction, and bearing a plurality of substrates in a manner that the plurality of substrates are parallel to the vertical direction, the plurality of substrates including a first substrate adjacent to a major surface of the connecting member;

wherein the connecting member further includes a flow rectifying portion, a major surface of the flow rectifying portion is flush with a major surface of the connecting main body, and the flow rectifying portion is configured such that when the bearing member bears the substrates, the orthographic projection of the first substrate on the flow rectifying portion is located inside the flow rectifying portion.

2. The substrate bearing device according to claim 1, wherein the spacing between the flow rectifying portion and the first substrate is 1 time to 3 times the spacing between adjacent substrates.

3. The substrate bearing device according to claim 2, wherein the spacing between the flow rectifying portion and the first substrate is 1 time to less than 2 times the spacing between adjacent substrates.

4. The substrate bearing device according to claim 3, wherein the plurality of substrates include a second substrate adjacent to the first substrate, and the flow rectifying portion and the second substrate are symmetrical about the first substrate.

5. The substrate bearing device according to claim 1, wherein the flow rectifying portion has the same shape as the first substrate.

6. The substrate bearing device according to claim 5, wherein the flow rectifying portion is concentric with the orthographic projection of the first substrate on the flow rectifying portion, and the area of the major surface of the flow rectifying portion is 1

time to 1.01 times the area of the major surface of the first substrate.

7. The substrate bearing device according to claim 1, wherein the connecting member further includes a reinforcing portion located below the flow rectifying portion, and the bearing member is connected to the flow rectifying portion and/or the reinforcing portion.

8. The substrate bearing device according to claim 1, wherein the flow rectifying portion and the connecting main body are integrally molded, or the flow rectifying portion is configured to be formed on the connecting main body by means of additive manufacturing.

9. A substrate processing apparatus, comprising:

a processing tank, for containing processing liquid;

the substrate bearing device according to any one of claims 1 to 8, arranged in the processing tank;

a bubbler, arranged in the processing tank and located below the bearing member, for supplying bubbles into the processing liquid.

10. The substrate processing apparatus according to claim 9, wherein the processing tank includes an inner tank and an outer tank, the inner tank is used for accommodating the substrate bearing device and storing the processing liquid submerging the plurality of substrates, the inner tank includes two first side walls oppositely arranged and two second side walls oppositely arranged, the second side walls are parallel to the substrates, the overflow levels of the first side walls are lower than the top surfaces of the second side walls, and the overflow levels are used for making the processing liquid overflow from the overflow levels of the two first side walls into the outer tank.

11. The substrate processing apparatus according to claim 9, wherein the bubbler includes:

a bubbling plate, facing the bearing member, provided with a plurality of openings;

a bubbling chamber, for supplying gas to the plurality of openings;

wherein the interior of the bubbling chamber includes at least two mutually independent gas channels, and the gas supply flow rates of the at least two gas channels are independently controlled.

12. The substrate processing apparatus according to claim 9, wherein the bubbler includes at least two bubbling units, the top surface of each bubbling unit is provided with a plurality of openings, a bubbling chamber is formed inside each bubbling unit and used for supplying gas to the plurality of openings, and the bubbling chamber includes at least one gas channel that can be independently controlled.