SUBSTRATE POLISHING DEVICE AND METHOD OF USING THE SAME

TECHNICAL FIELD

The present disclosure relates to the technical field of substrate polishing, and in particular to a substrate polishing device and a method of using the same.

BACKGROUND

An integrated circuit is a circuit with specific functions that integrates a certain number of electronic components and the wiring among these components using a certain process. Chemical Mechanical Polishing (CMP) technology is a means of achieving planarization in integrated circuit manufacturing. It uses a combination of surface chemistry and mechanical grinding to remove different materials at nanometre level from the surface of the substrate.

In the traditional polishing process, before polishing, the substrate is loaded into the polishing head using a secondary vacuum. The principle of the secondary vacuum is that an elastic membrane is connected to the bottom of the polishing head; and the bottom of the elastic membrane deforms toward the polishing head, thereby forming a vacuum region between the bottom of the elastic membrane and the substrate. The substrate is attached to the elastic membrane under the action of negative pressure. This method has poor controllability and is time consuming, and there is also a possibility of loading failure. During the polishing process, the substrate is pressed against the polishing pad by the polishing head, and the substrate is being polished, i.e. planarized, with the abrasives, chemical liquids, and etc. in the slurry. In order to prevent slipping during the polishing process, a retaining ring needs to be provided on the polishing head. The substrate is located in the retaining ring, and the bottom surface of the retaining ring needs to be kept at the same height as the bottom surface of the substrate. Therefore, the retaining ring will also be in contact with the polishing pad, participating in the polishing together with the substrate. The retaining ring is an important and costly consumable. This increases the grinding costs. Due to the presence of slurry between the substrate and the polishing head, it is difficult to unload the substrate after the completion of polishing, which increases the overall time of the polishing process.

SUMMARY

Therefore, the technical problem to be solved by the present disclosure is to overcome the problems in the prior art that: before polishing, it is difficult to load the substrate to the polishing head through the secondary vacuum; and after polishing, it is difficult to unload the substrate from the polishing head, which increases the overall time of the polishing process; and that it is necessary to use a retaining ring throughout the entire process, which increases the cost of grinding. Accordingly, there is provided a substrate polishing device and a method of using the same.

In order to solve the above problems, the present disclosure provides a substrate polishing device, including:

a polishing head, wherein a first gas passage is provided in the polishing head; and a suction disk, wherein the top of the suction disk is connected to the bottom of the polishing head, and the bottom of the suction disk is provided with a pore in communication with the first gas passage, and a contact surface around the pore.

Optionally, a plurality of the pores are provided at the bottom of the suction disk.

Optionally, the plurality of pores are evenly distributed on the bottom of the suction disk from centre to edge.

Optionally, a second gas passage in communication with the first gas passage, and a plurality of third gas passages in communication with the second gas passage, are provided in the suction disk; the third gas passages each extend from a central position at the bottom of the suction disk towards an edge position; and the plurality of pores are arranged at intervals and are in communication with the third gas passages.

Optionally, the suction disk comprises a connection part and a suction part; the connection part is located between the polishing head and the suction part; the second gas passage is in the connecting part; the third gas passages are in the suction part; the plurality of pores open at the bottom of the suction part.

Optionally, the connection part and the suction part are integrally formed.

Optionally, the first gas passage extends to top of the polishing head and is in communication with an external negative pressure device.

Optionally, a gas pressure sensor is provided at the first gas passage.

The present disclosure provides a method of using the substrate polishing device, the method including:

placing a substrate at the bottom of the suction disk and in contact with the pore;

providing negative pressure to the pore through the first gas passage; and

holding the substrate with the pore under negative pressure, and controlling the polishing head to start rotation.

Optionally, the method further comprises:

controlling the polishing head to stop rotation; and

stopping provision of negative pressure from the first gas passage to the pore, or providing gas pressure from the first gas passage to the pore.

The technical solutions of the present disclosure have the following benefits:

1.The substrate polishing device provided by the present disclosure includes a polishing head and a suction disk. A first gas passage is provided in the polishing head. The top of the suction disk is connected to the bottom of the polishing head, and the bottom of the suction disk is provided with a pore in communication with the first gas passage, and a contact surface around the pore.

When in use, the substrate may be placed at the bottom of the suction disk, and the bottom surface of the suction disk is in contact with the substrate. The first gas passage in the polishing head provides negative pressure to the pore. With the negative pressure, the substrate is held with suction by pore; and the substrate may be pressed against the contact surface around the pore. When the polishing head rotates, the suction disk rotates synchronously with the polishing head, and the substrate will not be displaced relative to the suction disk under the suction force from the pore and the frictional force on the contact surface. After grinding is completed, the provision of negative pressure to the pore through the first gas passage may be stopped; or a gas pressure may be provided to the pore through the first gas passage, so that the substrate may be easily unloaded.

Therefore, in the substrate polishing device provided by the present disclosure, it may suck the substrate directly through the negative pressure of the pore, and thus shorten the loading time of the substrate on the polishing head. The suction force from the pore and the frictional force on the contact surface may cause the substrate to be firmly held at the bottom of the suction disk, and thus there is no need for a retaining ring, thereby reducing the grinding costs. In addition, when unloading the substrate, the first gas passage may not provide negative pressure to the pore, or it may provide a gas pressure to the pore, so that the substrate can be quickly unloaded, thereby reducing the overall time of the grinding process and improving the efficiency of the grinding process.

2. In the substrate polishing device provided by the present disclosure, a plurality of pores are provided at the bottom of the suction disk. The plurality of pores are all connected to the first gas passage, and the plurality of pores may all provide negative pressure to improve the stability of suction on the substrate.

3. In the substrate polishing device provided by the present disclosure, the plurality of pores are evenly distributed on the bottom of the suction disk from centre to edge. The plurality of pores are evenly distributed on the bottom of the suction disk from centre to edge, i.e. forming a uniform suction force on the substrate. This ensures that during rotation of the substrate, a balanced force is applied to the substrate, preventing separation of the substrate from the suction disk.

4. In the substrate polishing device provided by the present disclosure, a second gas passage in communication with the first gas passage, and a plurality of third gas passages in communication with the second gas passage, are provided in the suction disk; the third gas passages each extend from a central position at the bottom of the suction disk towards an edge position; and the plurality of pores are arranged at intervals and are in communication with the third gas passages.

The negative pressure provided by the first gas passage is provided to each third gas passage through the second gas passage, and the plurality of pores are connected to the third gas passage, ensuring that the negative pressure of each pore is the same. Thus, it is ensured that the substrate is subject to the same suction force at different positions.

5. In the substrate polishing device provided by the present disclosure, the suction disk comprises a connection part and a suction part; the connection part is located between the polishing head and the suction part; the second gas passage is in the connecting part; the third gas passages are in the suction part; the plurality of pores open at the bottom of the suction part. The top of the connection part may be connected to the bottom of the polishing head. The first gas passage is in communication with the second gas passage. The third gas passages are located in the suction part and are in communication with the second gas passage. The connection part is only provided with the second gas passage, ensuring the structural stability of the connection part and ensuring that the connection part rotates synchronously with the polishing head.

6. In the substrate polishing device provided by the present disclosure, the connection part and the suction part are integrally formed, ensuring the overall strength of the suction disk.

7. In the substrate polishing device provided by the present disclosure, the first gas passage extends to the top of the polishing head and is connected to an external negative pressure device. The negative pressure device provides negative pressure to the first gas passage.

8. In the substrate polishing device provided by the present disclosure, a gas pressure sensor is provided at the first gas passage. In general, during the substrate grinding process, the gas pressure signal detected by the gas pressure sensor remains unchanged or within a specified threshold range. If the gas pressure signal detected by the gas pressure sensor changes beyond the threshold range, it indicates that the substrate is detached from the pores at this time. Thus, the occurrence of slipping of the substrate can be timely detected, and the polishing head can be controlled to stop rotation in a timely manner.

BRIEF DESCRIPTION OF DRAWINGS

In order to more clearly illustrate embodiments of the present disclosure or the technical solutions in the prior art, the following will briefly describe the drawings used in the description of the embodiments or the prior art. Clearly, the drawings of the following descriptions are some embodiments of the present disclosure. Those of ordinary skill in the art may obtain other drawings based on these drawings without creative effort.

Fig. 1 is a schematic structural diagram of a substrate polishing device in an embodiment of the present disclosure;

Fig. 2 is a schematic structural diagram illustrating the separation of the suction disk and the substrate in an embodiment of the present disclosure;

Fig. 3 is a schematic structural diagram of the bottom of the suction disk in an embodiment of the present disclosure;

Fig. 4 is a schematic structural diagram illustrating sliding of the substrate with respect to the suction disk in an embodiment of the present disclosure.

Reference numerals:

1. polishing head; 11. first gas passage; 12. second gas passage; 13. third gas passage; 2. suction disk; 21. connection part; 22. suction part; 3. pore; 31. contact surface; 4. substrate.

DETAILED DESCRIPTION

The technical solutions of the present disclosure will be more clearly and completely described below with reference to the drawings. Clearly, the described embodiments are

only some of the embodiments of the present disclosure, not all of the embodiments. Based on the embodiments in the present disclosure, all other embodiments obtainable by those of ordinary skill in the art without creative efforts shall fall within the protection scope of the present disclosure.

In the description of the present disclosure, it should be noted that orientation or positional relationship indicated by the terms "centre", "upper", "lower", "left", "right", "vertical", "horizontal", "inner", "outer", etc. is based on the orientation or positional relationship as shown in the drawings, only for the convenience of describing and simplifying the description, and does not indicate or imply that the referred apparatus or element must have a specific orientation, or constructed or operated in a specific orientation. Thus, it should not be construed as a limitation of the present disclosure. Further, the terms "first", "second", "third" are only used for descriptive purposes only and cannot be construed as indicating or implying relative importance.

In the description of the present disclosure, it should be noted that, unless otherwise expressly specified and limited, the terms "install", "connect" and "connection" should be construed in a broad sense. For example, it may be a fixed connection or a detachable connection, or integral connection. It may be mechanical connection or electrical connection. It may be direct connection, or indirect connection through an intermediate medium, or internal communication between two components. For those of ordinary skill in the art, the specific meanings of the above terms in the present disclosure can be understood in specific situations.

In addition, the technical features involved in the different embodiments of the present disclosure described below can be combined with each other as long as they do not conflict with each other.

Referring to Fig. 1 and Fig. 2, in one embodiment of the present disclosure, the substrate polishing device includes a polishing head 1 and a suction disk 2. A first gas passage 11 is provided in the polishing head 1; the top of the suction disk 2 is connected to the bottom of the polishing head 1, and the bottom of the suction disk 2 is provided with a pore 3 connected to the first gas passage, and a contact surface 31 around the pore.

In detail, the top of the polishing head 1 may be connected to a rotating shaft, and the rotating shaft is connected to an external driving motor. The driving motor may drive the polishing head 1 to rotate through the rotating shaft to facilitate subsequent grinding of the substrate 4. The suction disk 2 may be elastic. For example, the suction disk 2 may be made

of rubber, silicone, plastic, or other elastic materials. The pore 3 is opened at the bottom of the suction disk 2 and can be extended to communicate with the first gas passage 11, thereby facilitating the provision of negative pressure to the pore 3 by the first gas passage 11. The substrate 4 may be a wafer.

When in use, referring to Fig. 1, the substrate 4 may be placed at the bottom of the suction disk 2, and the bottom surface of the suction disk 2 is in contact with the substrate 4. The first gas passage 11 in the polishing head 1 provides negative pressure to the pore 3. With the negative pressure, the substrate 4 is held with suction by pore 3; and the substrate 4 may be pressed against the contact surface 31 around the pore 3. When the polishing head 1 rotates, the suction disk 2 rotates synchronously with the polishing head 1, and the substrate 4 will not be displaced relative to the suction disk 2 under the suction force from the pore 3 and the frictional force on the contact surface 31. In addition, since the suction disk 2 is elastic, when the pore 3 sucks the substrate 4, the pressure exerted by the substrate 4 on the contact surface 31 will slightly deform the contact surface 31, which helps improving the friction between the substrate 4 and the contact surface 31.

Referring to Fig. 2, after grinding is completed, the provision of negative pressure to the pore 3 through the first gas passage 11 may be stopped; or a gas pressure may be provided to the pore 3 through the first gas passage 11, so that the substrate may be easily unloaded.

Therefore, in the substrate polishing device provided by the present disclosure, it may suck the substrate 4 directly through the negative pressure of the pore 3, and thus shorten the loading time of the substrate 4 on the polishing head 1. The suction force from the pore 3 and the frictional force on the contact surface 31 may cause the substrate 4 to be firmly held at the bottom of the suction disk 2, and thus there is no need for a retaining ring, thereby reducing the grinding costs. In addition, when unloading the substrate 4, the first gas passage 11 can be used not only for removing the negative pressure of the pore 3, but also for providing a gas pressure to the pore 3, so that the substrate 4 can be quickly unloaded, thereby reducing the overall time of the grinding process, improving the efficiency of the grinding process.

Referring to Fig. 1 and Fig. 3, in one embodiment of the present disclosure, a plurality of the pores 3 are provided at the bottom of the suction disk 2. The contact surfaces 31 are around each of the plurality of pores 3. The plurality of pores 3 are all connected to the first

gas passage 11, and the plurality of pores 3 may all provide negative pressure to improve the stability of suction on the substrate 4.

Referring to Fig. 1 and Fig. 3, in one embodiment of the present disclosure, the plurality of pores 3 are evenly distributed on the bottom of the suction disk 2 from centre to edge. For example, the plurality of pores 3 are evenly distributed on the bottom of the suction disk 2 from centre to edge along straight lines. The plurality of pores 3 along a straight line may be marked as a group of pores. The plurality of groups of pores are evenly distributed about the centre at the bottom of the suction disk 2. At the bottom of the suction disk 2, the plurality of pores 3 may be distributed in an array, or distributed in an annular pattern, or forming a symmetrical shape. The embodiments are not limited to specific manner of distribution of the pores 3.

As the plurality of pores 3 are evenly distributed on the bottom of the suction disk 2 from centre to edge, when the first gas passage 11 provides a negative pressure, the suction forces of the plurality of pores 3 are the same, and the suction forces on the substrate at positions corresponding the pores 3 are also the same, that is, a uniform suction force on the substrate 4 is formed. This further ensures that the pressure and friction between the contact surfaces 31 and the substrate 4 are also the same, such that during rotation of the substrate 4, a balanced force is applied to the substrate 4, preventing separation of the substrate 4 from the suction disk 2.

Referring to Fig. 1 and Fig. 3, in one embodiment of the present disclosure, the suction disk 2 is provided with a second gas passage 12 connected to the first gas passage 11, and a plurality of third gas passages 13 connected to the second gas passage 12; the third gas passages 13 each extend from centre to edge at the bottom of the suction disk 2; the plurality of pores 3 are positioned at intervals and are in communication with the third gas passages 13. For example, six third gas passages 13 are evenly arranged around the centre of the suction disk 2, and multiple pores 3 are provided at intervals at the bottom of the suction disk 2 corresponding to each third gas passage 13. The multiple pores 3 are each in communication with the third gas passage 13. The second gas passage 12 is at the centre of the suction disk 2. The plurality of third gas passages 13 are in communication with the second gas passage 12, and the second gas passage 12 is in communication with the first gas passage 11. Thus, the first gas passage 11 may provide negative pressure to each pore 3 through the second gas passage 12 and the third gas passages 13.

The negative pressure provided by the first gas passage 11 is provided to each third gas passage 13 through the second gas passage 12, and the plurality of pores 3 are connected to the third gas passages 13, ensuring that the negative pressure of each pore 3 is the same. Thus, it is ensured that the substrate 4 is subject to the same suction force at different positions.

Referring to Fig. 1, in one embodiment of the present disclosure, the suction disk 2 comprises a connection part 21 and a suction part 22; the connection part 21 is located between the polishing head 1 and the suction part 22; the second gas passage 12 is in the connecting part 21; the third gas passages 13 are in the suction part 22; the plurality of pores 3 open at bottom of the suction part 22.

The top of the connection part 21 may be connected to the bottom of the polishing head 1, for example, using glue. The first gas passage 11 is in communication with the second gas passage 12. The third gas passages 13 are located in the suction part 22 and are in communication with the second gas passage 12. Since the connection part 21 is directly connected to the bottom of the polishing head 1 and the polishing head 1 will generate a large rotational force during rotation, the connection part 21 is only provided with the second gas passage 12, which helps to ensure the strength of the connection part 21. This further ensures the stability of the connection structure between the polishing head 1 and the connection part 21, prevents the connection part 21 from falling off the polishing head 1, and ensures that the connection part 21 rotates synchronously with the polishing head 1.

In one embodiment of the present disclosure, the connection part 21 and the suction part 22 are integrally formed. For example, an integral molding process or 3D printing may be used to produce the suction disk 2 according to the designed size, and to construct the gas passages in the suction disk 2, ensuring the overall strength of the suction disk.

In one embodiment of the present disclosure, the first gas passage extends to the top of the polishing head and is connected to an external negative pressure device. A negative pressure device may provide negative pressure to the first gas passage.

Referring to Fig. 4, in one embodiment of the present disclosure, a gas pressure sensor is provided at the first gas passage. In general, during the substrate grinding process, the gas pressure signal detected by the gas pressure sensor remains unchanged or within a specified threshold range. If the gas pressure signal detected by the gas pressure sensor changes beyond the threshold range, it indicates that the substrate 4 is detached from the pores 3 at

this time. Thus, the occurrence of slipping of the substrate 4 can be timely detected, and the polishing head can be controlled to stop rotation in a timely manner.

The present disclosure provides a method of using a substrate polishing device, applied to the substrate polishing devices abovementioned, the method including:

placing a substrate at the bottom of the suction disk and in contact with the pore. The substrate is placed in the corresponding position at the bottom of the suction disk according to the operating specifications, and corresponds to the pore.

providing negative pressure to the pore through the first gas passage. The first gas passage provides negative pressure to the pore, and the pore sucks and hold the substrate firmly under negative pressure. The suction manner can reduce the loading time of the substrate and improve the working efficiency.

holding the substrate with the pore under negative pressure, and controlling the polishing head to start rotation. Based on the above description of the structure of the substrate polishing device, after the pores suck and hold the substrate, the substrate comes into contact with the contact surface, making it difficult for the substrate to displace relative to the suction disk under the suction force and frictional force.

It should be noted that the substrate polishing device in this embodiment is structurally identical to the substrate polishing device described above. Those skilled in the art can refer to the above description to deduce the specific motion relationship among the components, which will not be described in detail in this embodiment.

In one embodiment of the present disclosure, the method further includes:

controlling the polishing head to stop rotation. The polishing head can be controlled to stop rotating by controlling the drive motor to stop working.

stopping provision of negative pressure from the first gas passage to the pore, or providing gas pressure from the first gas passage to the pore. After the polishing head stops rotating completely, the unloading of the substrate may begin. The first gas passage may stop providing negative pressure to the pore, or it may provide a gas pressure to the pore. Either way, the pore will no longer suck and hold the substrate. The latter may accelerate the separation of the substrate from the suction disk through gas pressure.

Clearly, the above embodiments are only examples for clear description, and are not intended to limit the manner of implementation. For those of ordinary skill in the art, there are other variations or changes that can be made in different forms based on the above description. It is not necessary or possible to exhaust all embodiments here. The obvious

variations or changes derived therefrom are still within the protection scope of the present disclosure.

CLAIMS

1. A substrate polishing device, comprising:

a polishing head (1), wherein a first gas passage (11) is provided in the polishing head (1); and

a suction disk (2), wherein top of the suction disk (2) is connected to bottom of the polishing head (1), and bottom of the suction disk (2) is provided with a pore (3) in communication with the first gas passage (11), and a contact surface (31) around the pore (3).

2. The substrate polishing device according to claim 1, wherein a plurality of the pores (3) are provided at the bottom of the suction disk (2).

3. The substrate polishing device according to claim 2, wherein the plurality of pores (3) are evenly distributed on the bottom of the suction disk (2) from centre to edge.

4. The substrate polishing device according to claim 3, wherein a second gas passage (12) in communication with the first gas passage (11), and a plurality of third gas passages (13) in communication with the second gas passage (12), are provided in the suction disk (2); the third gas passages (13) each extend from a central position at the bottom of the suction disk (2) towards an edge position; and the plurality of pores (3) are arranged at intervals and are in communication with the third gas passages (13).

5. The substrate polishing device according to claim 4, wherein the suction disk (2) comprises a connection part (21) and a suction part (22); the connection part (21) is located between the polishing head (1) and the suction part (22); the second gas passage (12) is in the connecting part (21); the third gas passages (13) are in the suction part (22); the plurality of pores (3) open at bottom of the suction part (22).

6. The substrate polishing device according to claim 5, wherein the connection part (21) and the suction part (22) are integrally formed.

7. The substrate polishing device according to claim 1, wherein the first gas passage (11) extends to top of the polishing head (1) and is in communication with an external negative pressure device.

8. The substrate polishing device according to claim 2, wherein a gas pressure sensor is provided at the first gas passage (11).

9. A method of using a substrate polishing device according to any one of claims 1 to 8, comprising:

placing a substrate at the bottom of the suction disk and in contact with the pore;

providing negative pressure to the pore through the first gas passage; and

holding the substrate with the pore under negative pressure, and controlling the polishing head to start rotation.

10. The method according to claim 9, further comprising:

controlling the polishing head to stop rotation; and

stopping provision of negative pressure from the first gas passage to the pore, or providing gas pressure from the first gas passage to the pore.