

DESCRIPTION

SPLIT UNIVERSAL JOINT FOR CARRIER HEAD AND POLISHING DEVICE

TECHNICAL FIELD

The present invention relates to a universal joint for a carrier head, in particular to a split universal joint for a carrier head and a polishing device.

BACKGROUND

In the process of manufacturing an integrated circuit, it is inevitable to deposit several layers of stacked structures of different materials on a wafer. This causes irregularities on the surface of the wafer. The irregular wafer surface can lead to some problems in a lithographic process, such as an insufficient depth of focus (DOF) and an image transfer deviation. Therefore, in the process of manufacturing the integrated circuit, it often needs to planarize the irregular surface of the wafer by planarization technology, such as CMP technology

In the CMP technology, a wafer to be polished is pressed, facing downward, onto a polishing pad, and the wafer to be polished is fixed by a disc-like mechanism called a carrier head. In a polishing stage, the carrier head brings the wafer to be polished into rotation around a fixed shaft, while the polishing pad rotates around another rotating shaft, and then a dielectric layer or a metallic layer to be removed from the wafer surface is removed by polishing in a chemical or mechanical manner. A common carrier head at present is a design called a floating carrier head, which uses a flexible membrane to fix a wafer supporting disc or a backing plate under a base. In the polishing stage, a pressure can be applied to the wafer supporting disc by using gas to evenly distribute a downforce applied to the back of the wafer.

A common problem with the CMP process in the early period was that the pattern distribution and height differences on the surface of the wafer to be polished were often uneven, such that a force applied to the wafer during polishing tended to vary greatly.

Later, in order to solve this problem, modifications were made to the carrier head. A modified carrier head, as shown in Fig. 1, is a multi-zone airbag structure. It generally consists of a connecting disc 1a, a flexible membrane polishing part, and a rotary seal ring 3a connecting

the connecting disc and the flexible membrane polishing part. The connecting disc 1a is fixedly connected to a rotating shaft of the carrier head, and the connecting disc 1a is provided with a channel 10a in the center. The flexible membrane polishing part includes a base 2a, a flexible airbag 5a located at a lower opening of the base 2a, and a universal joint 4a located in an upper opening of the base 2a and fixedly mounted thereto. This universal joint is usually made of metal. The universal joint 4a extends, in an inverted T shape, into the channel 10a of the connecting disc 1a, and can move downward or move upward in the channel 10a when the rotary seal ring 3a expands by inflation or contracts under vacuum, so that a force applied by the carrier head to a wafer 6a is uniform. This universal joint 3a can also offset, by elastic deformation thereof, a non-parallel difference between a carrier head part and a polishing pad part.

As shown in Fig. 2, when a bottom surface of the wafer 6a is not parallel, the connecting disc 1a is deflected relative to the base 2a, and the connecting disc 1a abuts against the universal joint 4a, such that a force on the universal joint 4a at a corner position (such as a circled position in Fig. 2) is concentrated, and plastic deformation or even cracking is liable to occur here. Moreover, due to the integrated T-shaped structure, the universal joint is difficult to process, high in processing cost, and accordingly, high in replacement cost.

SUMMARY OF THE INVENTION

An object of the present invention is to overcome the shortcomings in the prior art that a universal joint is T-shaped and difficult to process, and is prone to plastic deformation or even cracking at corners during use, resulting in a failure of a carrier head; and thus, to provide a split universal joint for a carrier head and a polishing device, which split universal joint is easy to process and not prone to plastic deformation or even cracking.

The present invention provides a split universal joint for a carrier head, the carrier head having a connecting disc and a polishing part, the connecting disc being provided with a channel, and the polishing part having a base, wherein the split universal joint includes:

- a guide part adapted to float up and down in the channel;
- a fixed part adapted to be fixedly connected to the base; and

a connecting structure connected between the guide part and the fixed part and fixedly connected to the guide part and the fixed part, respectively, the guide part being adapted to swing relative to the fixed part by means of the connecting structure.

Optionally, the connecting structure is a flexible structure, which is connected at one end to the guide part and connected at the other end to the fixed part.

Optionally, the connecting structure is detachably connected at one end to the guide part and detachably connected at the other end to the fixed part.

Optionally, the fixed part is provided with a first connecting hole, and one end of the connecting structure is embedded in the first connecting hole and connected to the first connecting hole by an elastic ring; and/or the guide part is provided with a second connecting hole at a lower end, and the other end of the connecting structure is embedded in the second connecting hole and connected to the second connecting hole by an elastic ring.

Optionally, the connecting structure is made of rubber.

Optionally, an outer side of the connecting structure is provided with tooth-like projections.

Optionally, the guide part is made of a metal material.

Optionally, the fixed part is made of metal.

Optionally, the fixed part and the connecting structure are formed integrally.

The present invention further provides a polishing device including the split universal joint for a carrier head.

BRIEF DESCRIPTION OF THE DRAWINGS

To describe technical solutions in the embodiments of the present invention or in the prior art more clearly, drawings for use in description of the embodiments or the prior art will be introduced briefly below. Obviously, the drawings described below only represent some embodiments of the present invention, and those of ordinary skill in the art can also obtain other drawings according to these drawings without creative work.

Fig. 1 is a cross-sectional diagram of a polishing device containing a universal joint in the prior art;

Fig. 2 is a schematic diagram of cooperation when a connecting disc is tilted relative to a base.

Fig. 3 is a cross-sectional diagram of a polishing device containing a split universal joint for a carrier head provided in an embodiment of the present invention; and

Fig. 4 shows a schematic diagram of a second embodiment of a split universal joint for a carrier head.

Reference numerals

1, connecting disc; 10, channel; 2, base; 3, rotary seal ring; 4, split universal joint; 40, guide part; 41, connecting structure; 42, fixed part; 43, projection; 46, first clamping rod; 47, second clamping rod; 48, elastic ring; 5, polishing part; 6, wafer.

DETAILED DESCRIPTION

Technical solutions of the present invention will be described below clearly and completely in conjunction with the accompanying drawings. Obviously, the described embodiments are only part of, instead of all of embodiments of the present invention. Based on the embodiments in the present invention, all of other embodiments obtained by those of ordinary skill in the art without creative work should fall into the protection scope of the present invention.

In the description of the present invention, it is to be noted that, unless otherwise specified and defined expressly, the terms "install", "be connected with" and "be connected" should be construed in a broad sense. For example, it may indicate "fixed connection", "detachable connection" or "integral connection"; it may indicate "mechanical connection" or "electrical connection"; and it may indicate "direct connection", "indirect connection by an intermediate medium" or "internal communication between two elements". For those of ordinary skill in the art, specific meanings of the above-mentioned terms in the present invention may be construed according to specific conditions.

In addition, technical features involved in different implementations of the present invention described below may be combined with each other so long as they do not conflict with each other.

Referring to Fig. 3, a cross-sectional diagram of a polishing device including a split universal joint for a carrier head is shown. The carrier head is a multi-zone airbag structure including a connecting disc 1 and a polishing part 5, which are connected by a rotary seal ring 3. The connecting disc 1 is fixedly connected to a rotating shaft of a machine, and is provided with a channel 10 in the middle. The polishing part 5 includes a base 2, and the split universal joint 4 is fixed to the base 2. When the rotary seal ring 3 expands by inflation, the base 2 moves downward relative to the connecting disc 1, and the split universal joint 4 moves downward in the channel 10 therewith. When the rotary seal ring 3 contracts under vacuum, the base 2 moves upward relative to the connecting disc 1, and the split universal joint 4 moves upward in the channel 10 therewith. When the surface flatness of a wafer 6 is not good, the connecting disc 1 and the base 2 tilt relative to each other, causing the split universal joint 4 to be squeezed.

In a first embodiment, the split universal joint 4 is an inverted T-shaped structure overall and includes a fixed part 42, a connecting structure 41 and a guide part 40. The fixed part 42 is fixedly connected to the base 2. The fixed part 42 and the guide part 40 are cylindrical, and are both made of metal. They are simple in shape, convenient to process, relatively low in processing cost and low in defect rate.

The connecting structure 41 is connected between the guide part 40 and the fixed part 42 and fixedly connected to the guide part 40 and the fixed part 42, respectively, and the guide part 40 can swing relative to the fixed part 42 by means of the connecting structure 41. In this embodiment, the connecting structure 41 is a flexible structure and is made of rubber to achieve better elasticity. When the connecting disc 1 and the base 2 are not parallel to a large extent, a force applied by the connecting disc 1 to the guide part 40 can be absorbed by the connecting structure 41, thereby protecting the fixed part 42 and the guide part 40 from the action of a large external force, thus avoiding phenomena such as cracking and plastic deformation. Specifically, when the connecting disc 1 tilts relative to the base 2, the connecting disc 1 abuts against the guide part 40, and the guide part 40 transmits the force applied by the connecting disc 1, to the connecting structure 41 connected therewith, such that the connecting structure 41 elastically deforms to one side, and thus causes the guide part 40 connected therewith to swing relative to the fixed part 42. Of course, the flexible structure may also be made of other flexible materials. An outer side of the flexible structure is provided with tooth-like projections

43, which can further reduce a deformation resistance of the split universal joint 4 and better adapt to the unevenness of the surface of the wafer 6.

The flexible structure is detachably connected at one end to the fixed part 42 and detachably connected at the other end to the guide part 40. A detachable connection mode is adopted here, which can facilitate subsequent replacement of the flexible structure. Specifically, the fixed part 42 is provided with a first connecting hole, the flexible structure is provided with a first clamping rod 46 at one end, and the first clamping rod 46 is clamped and connected with the first connecting hole; and the guide part 40 is provided with a second connecting hole, the flexible structure is provided with a second clamping rod 47, and the second clamping rod 47 is clamped and connected with the second connecting hole. The guide part 40 and the connecting structure 41 can float up and down in the channel 10.

When the rotary seal ring 3 expands by inflation, the split universal joint 4 moves downward together with the base 2, and accordingly, the guide part 40 and the connecting structure 41 move downward in the channel 10. When the rotary seal ring 3 contracts under vacuum, the split universal joint 4 moves upward together with the base 2, and accordingly, the guide part 40 and the connecting structure 41 move upward in the channel 10. When the surface of the wafer 6 is uneven, the connecting disc 1 and the base 2 are no longer parallel and tilt relative to each other, and the connecting disc 1 abuts against the split universal joint 4, and the connecting structure 41 swings to meet their tilting demand. After the connecting structure 41 swings several times, resulting in relatively large deformation such that it is no longer suitable for use, it can be directly removed and replaced.

In the first embodiment, the first connecting hole may also be formed in the flexible structure, and accordingly, the first clamping rod 46 is provided on the fixed part 42; and the second connecting hole may also be formed in the flexible structure, and accordingly, the second clamping rod 47 is provided on the guide part 40. This is an alternative readily conceivable to those skilled in the art and should be within the scope of protection of the present application.

Fig. 4 shows a second embodiment of the present invention, in which the split universal joint 4 includes a guide part 40, a fixed part 42 and a connecting structure 41. All of the three are made of metal. The fixed part 42 is provided with a first connecting hole with an elastic ring 48 arranged therein, and a first clamping rod 46 of the connecting structure 41 is clamped

in the first connecting hole by means of the elastic ring 48; and a lower end of the guide part 40 is provided with a second connecting hole with an elastic ring 48 arranged therein, and a second clamping rod 47 of the connecting structure 41 is embedded in the second connecting hole by means of the elastic ring 48. Due to the arrangement of the elastic rings 48, the split universal joint 4 can swing to a relatively large extent in the channel 10, and therefore can adapt to the relatively large extent of non-parallel between the connecting disc 1 and the base 2, and thus better adapt to the unevenness of the surface of the wafer 6 and better polish the surface of the wafer 6.

In the invention, there is also a third embodiment, which differs from the second embodiment in that the guide part and the thus, connecting structure are connected into one piece. The fixed part is provided with a first connecting hole with an elastic ring arranged therein, and the connecting structure is clamped and connected in the first connecting hole of the fixed part by means of the elastic ring. Due to the arrangement of the elastic ring, the split universal joint for a carrier head can swing to a relatively large extent in the channel, and therefore can adapt to the relatively large extent of non-parallel between the connecting disc and the base, and thus better adapt to the unevenness of the surface of the wafer and better polish the surface of the wafer.

Obviously, the embodiments described above are merely examples for clear description, and are not intended to limit the implementations. Other variations or modifications in various forms can also be made by those of ordinary skill in the art, based on the above description. It is not necessary or possible to be exhaustive of all implementations here. Obvious variations or modifications derived therefrom are still within the scope of protection of the invention-creation.

CLAIMS

1. A split universal joint for a carrier head, the carrier head having a connecting disc (1) and a polishing part, the connecting disc (1) being provided with a channel (10), and the polishing part having a base (2), wherein the split universal joint comprises:
a guide part (40) adapted to float up and down in the channel (10);
a fixed part (42) adapted to be fixedly connected to the base (2); and
a connecting structure (41) connected between the guide part (40) and the fixed part (42) and fixedly connected to the guide part (40) and the fixed part (42), respectively, the guide part (40) being adapted to swing relative to the fixed part (42) by means of the connecting structure (41).

2. The split universal joint for a carrier head according to claim 1, wherein the connecting structure (41) is a flexible structure, which is connected at one end to the guide part (40) and connected at the other end to the fixed part (42).

3. The split universal joint for a carrier head according to claim 2, wherein the connecting structure (41) is detachably connected at one end to the guide part (40) and detachably connected at the other end to the fixed part (42).

4. The split universal joint for a carrier head according to claim 2, wherein the fixed part (42) is provided with a first connecting hole, and one end of the connecting structure (41) is embedded in the first connecting hole and connected to the first connecting hole by an elastic ring (48);

and/or the guide part (40) is provided with a second connecting hole at a lower end, and the other end of the connecting structure (41) is embedded in the second connecting hole and connected to the second connecting hole by an elastic ring (48).

5. The split universal joint for a carrier head according to claim 2, wherein the connecting structure (41) is made of rubber.

6. The split universal joint for a carrier head according to claim 2, wherein an outer side of the connecting structure (41) is provided with tooth-like projections (43).

7. The split universal joint for a carrier head according to any one of claims 1-6, wherein the guide part (40) is made of a metal material.

8. The split universal joint for a carrier head according to any one of claims 1-6, wherein the fixed part (42) is made of metal.

9. The split universal joint for a carrier head according to claim 1, wherein the fixed part (42) and the connecting structure (41) are formed integrally.

10. A polishing device comprising the split universal joint for a carrier head according to any one of claims 1-9.