

CONTACT ASSEMBLY, CHUCK, AND ELECTROPLATING APPARATUS

FIELD OF THE INVENTION

The present invention relates to the technical field of semiconductor electroplating, and in particular to a contact assembly, a chuck, and an electroplating apparatus.

BACKGROUND

In the manufacturing process of semiconductor integrated circuits, the chemical electroplating process of wafers is an essential process for high-quality integrated circuits. In electroplating equipment, a chuck is required to fix a wafer, and a contact assembly is a key component of the chuck that contacts the seed layer on the wafer. The contact assembly is made of a conductive metallic material having a degree of elastic resilience, and the structure of the contact assembly and the physical properties of the material are among the key factors that affect the quality of the electroplating process.

The initial processing shapes of existing contact assemblies are arc-shaped. However, as the workpiece is not arc-shaped, the arc-shaped structure typically results in significant material waste during processing, and consumes excessive processing material, which leads to a relatively high processing cost.

SUMMARY

To solve the above-mentioned problem in the prior art, the present invention provides a contact assembly and a chuck. The contact assembly can be processed along a linear path during processing, thereby reducing material waste and the processing cost. The contact assembly also exhibits superior bending performance.

The present invention solves the above technical problem by providing the following technical solutions, comprising:

a contact assembly, extending along a linear path, comprising:

a mounting body, including a plurality of mounting portions arranged at intervals, the plurality of mounting portions being distributed along the length direction of the contact assembly, the adjacent mounting portions being separated by a first hollow area, and each mounting portion being provided with a guide portion protruding from the mounting body;

a contact body, provided with a plurality of second hollow areas distributed at intervals along the length direction of the contact assembly, and the contact body being connected to the mounting body for contacting a substrate.

Preferably, the mounting body further includes a connection portion, the connection portion extends along the length direction of the contact assembly, and the connection portion includes a first end surface and a second end surface disposed opposite to each other;

the first end surface is connected to the mounting body, and the mounting body extends outward from the first end surface along the width direction of the contact assembly;

the second end surface is connected to the contact body, and the contact body extends outward from the second end surface along the width direction of the contact assembly.

Preferably, the inner end surfaces of the first hollow areas extend to the first end surface, and/or the inner end surfaces of the second hollow areas extend to the second end surface.

Preferably, the guide portions are disposed at the ends of the mounting portions away from the connection portion.

Preferably, the shape of the contact assembly is rectangular.

Preferably, the contact body includes a plurality of extending portions, the plurality of extending portions are distributed along the length direction of the contact assembly, the second hollow area is disposed between the adjacent extending portions, the proximal end of each extending portion is connected to the mounting body, and the

distal end of each extending portion is provided with a contact portion for contacting the substrate.

Preferably, the contact portions are inclined relative to the horizontal plane, and each included angle with the horizontal plane is between 0° and 20°.

Preferably, the extending portions and the mounting body are in an arcuate transition.

The present invention further comprises:

a chuck, for holding a substrate, the chuck comprising an inner pressure ring; a frame; and the contact assembly described above, each mounting portion of the contact assembly being attached to and in close contact with the inner peripheral surface of the frame, the inner peripheral surface of the frame being provided with an annular groove, each guide portion of the contact assembly being disposed in the annular groove, and the contact assembly being press-fitted against the inner peripheral surface of the frame via the inner pressure ring.

Preferably, a gap is provided between the contact body of the contact assembly and the inner peripheral surface of the frame.

Preferably, the contact body of the contact assembly includes a plurality of extending portions, the plurality of extending portions extend along the length direction of the mounting body, a second hollow area is disposed between the adjacent extending portions, the proximal end of each extending portion is connected to the mounting body, the distal end of each extending portion is provided with a contact portion for contacting the substrate, and gaps are provided between the extending portions and the inner peripheral surface of the frame.

The present invention further comprises:

an electroplating apparatus, comprising the chuck described above.

The advantages of the present invention are: In the present invention, the contact assembly extends along a linear path, allowing the contact assembly to be processed

along a linear path during processing. For the same material area, compared with arc-shaped contact assemblies in the prior art, the contact assembly in the present invention has a higher material utilization rate, produces less waste, and yields a higher output rate. Therefore, the processing cost of the contact assembly provided by the present invention is lower. In addition, by providing a plurality of mounting portions distributed along the length direction of the contact assembly and separating the adjacent mounting portions via the first hollow area, the first hollow areas can reduce the stiffness and strength of the edge material of the mounting body, making the deformation of the edge material easier during the bending process. Moreover, the first hollow areas can reduce the moment of inertia of the contact assembly and enhance the bending performance of the contact assembly. Similarly, the arrangement of the second hollow areas can further enhance the bending performance of the contact assembly, making it easier for the contact assembly to be bent into a ring shape for use from a state of extending along a linear path. The guide portions protrude from the mounting portions. During use, the guide portions can guide the contact assembly to be bent into a ring shape, and can offset the spring-back produced by the contact assembly during the bending process via contact with other components, which is beneficial for the contact assembly to maintain the bent state, thereby improving the stability of the contact assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 shows a process schematic view of a contact assembly in the prior art;

FIG. 2 shows a process schematic view of the contact assembly in embodiment 1 of the present invention;

FIG. 3 shows a partial structural schematic view of the contact assembly in embodiment 1 of the present invention during use;

FIG. 4 shows a front structural schematic view of the contact assembly in embodiment 1 of the present invention;

FIG. 5 shows a partial enlarged structural schematic view of the contact assembly in embodiment 1 of the present invention;

FIG. 6 shows a side structural schematic view of the contact assembly in embodiment 1 of the present invention;

FIG. 7 shows an overall structural schematic view of the chuck in embodiment 2 of the present invention;

FIG. 8 shows an exploded structural schematic view of the chuck in embodiment 2 of the present invention;

FIG. 9 shows a cross-sectional schematic view of the exploded structure of the chuck in embodiment 2 of the present invention;

FIG. 10 shows an enlarged structural schematic view of part A in FIG. 9;

FIG. 11 shows a structural schematic view of the chuck in embodiment 2 of the present invention in the assembled state.

PREFERRED EMBODIMENTS OF THE INVENTION

To describe the technical content, structural features, achieved objects, and effects of the present invention in detail, a detailed description will be given below with reference to embodiments and accompanying drawings, but the present invention is not limited to the scope of the described embodiments.

In a wafer chuck of electroplating equipment, a contact assembly functions as a conductive component for contacting the seed layer on the front side of a wafer. The wafer is substantially circular. To adapt to the shape of the wafer and enable the contact assembly to uniformly contact the seed layer on the front side of the wafer, the contact assembly needs to be of a ring-shaped structure. Therefore, contact assemblies in the prior art are substantially arc-shaped after processing, and then a plurality of arc-shaped contact assemblies are joined end-to-end to form a complete ring-shaped contact assembly. The processing process of the contact assembly is shown in FIG. 1. A plurality of arc-shaped structures are cut from a square workpiece, and the structures

are then further processed into arc-shaped contact assemblies 200'. Due to the arc-shaped structure of the contact assemblies, a large amount of waste is produced during processing, resulting in a low material utilization rate and a high processing cost.

To reduce the processing cost, the present invention provides a bendable rectangular contact assembly 200, and the processing process of the contact assembly is shown in FIG. 2. During processing, a rectangular structure is used for processing, which produces less waste and yields a high output rate of the contact assembly 200. For the same workpiece area, more contact assemblies 200 can be processed, which significantly reduces the processing cost. During use, as shown in FIG. 3 (only a part of the structure of the contact assembly 200 is shown, which is actually ring-shaped), the contact assembly can be bent into a ring shape for use without affecting the performance of the contact assembly. The structure of the rectangular contact assembly 200 is described in detail below.

As shown in FIG. 4 (to more clearly show the structure of the contact assembly 200, only a part of the structure of the contact assembly 200 is shown) and FIG. 5, the contact assembly 200 extends along a linear path. Since the contact assembly 200 extends along a linear path, the contact assembly 200 can be processed along a linear path during processing. Under the same material area, compared with the arc-shaped contact assemblies 200' in the prior art, the contact assembly 200 has a higher material utilization rate, produces less waste, and yields a higher output rate. Therefore, the processing cost of the contact assembly 200 provided by the present invention is lower.

The contact assembly 200 comprises a mounting body 210, a contact body 220, and a connection portion 214. The connection portion 214 extends along the length direction L of the contact assembly 200, and the connection portion 214 includes a first end surface and a second end surface disposed opposite to each other. The first end surface of the connection portion 214 is connected to the mounting body 210, and the mounting body 210 extends outward from the first end surface of the connection portion 214 along the width direction W of the contact assembly 200. The second end surface of the connection portion 214 is connected to the contact body 220, and the contact body 220 extends outward from the second end surface of the connection portion 214 along the width direction W of the contact assembly 200. The mounting body 210 and the contact body 220 can be secured together via the connection portion

214 to form an integral structure. In addition, the connection portion 214 can also bear a defined tensile force or compressive load during the connection process to ensure a firm and stable connection between the mounting body 210 and the contact body 220, thereby improving the service life of the contact assembly 200.

Specifically, the mounting body 210 includes a plurality of mounting portions 211 arranged at intervals. The plurality of mounting portions 211 are distributed along the length direction L of the contact assembly 200, and the adjacent mounting portions 211 are separated by a first hollow area 212. Each mounting portion 211 is provided with a guide portion 213 protruding from the mounting body 210. The first hollow areas 212 can reduce the stiffness and strength of the edge material of the mounting body 210, making the deformation of the edge material easier during the bending process. Moreover, the first hollow areas 212 can reduce the moment of inertia of the mounting body 210 and improve the bending performance of the contact assembly 200. The guide portions 213 protrude from the mounting portions 211. During use, the guide portions can guide the contact assembly to be bent into a ring shape. In addition, as shown in FIG. 10, the guide portions 213 are inserted into an annular groove 310 provided on the chuck, and the arrangement can offset the reaction force produced by the contact assembly 200 during the bending process, which is beneficial for the contact assembly 200 to maintain the bent state, thereby improving the stability of the contact assembly 200.

Further, the inner end surfaces of the first hollow areas 212 extend to the first end surface of the connection portion 214, and the inner end surfaces of the second hollow areas 223 extend to the second end surface of the connection portion 214. The first hollow areas 212 and the second hollow areas 223 have large areas and have no impact on the connection portion 214, allowing the contact assembly 200 to possess bending performance and a defined strength. In other embodiments, the terminal extension distances of the first hollow areas 212 and the second hollow areas 223 are not limited thereto, and can be flexibly set as needed.

In one example, guide portions 213 are disposed at the ends of the mounting portions 211 away from the connection portion 214. The guide portions 213 are located at a substantial distance from the connection portion 214, and the moment produced by the guide portions is large, making it easier for the contact assembly 200 to be bent

into a ring shape.

In this embodiment, the contact body 220 includes a plurality of extending portions 221. The plurality of extending portions 221 are distributed along the length direction L of the contact assembly 200. A second hollow area 223 is disposed between the adjacent extending portions 221, the proximal end of each extending portion 221 is connected to the mounting body 210, and the distal end of each extending portion 221 is provided with a contact portion 222 for contacting the wafer.

The use of the plurality of extending portions 221 and the arrangement of the contact portions 222 increase the number of contact points between the contact assembly 200 and the wafer, improve the contact quality between the wafer and the contact body 220, and can maximize the contact area between the wafer and the contact body 220, allowing the wafer to be stably placed on the contact body 220, which is beneficial to improving the uniformity of electrical conduction. The arrangement of the second hollow area 223 between the adjacent extending portions 221 improves the bending performance of the contact assembly 200, making it easier for the contact assembly 200 to be bent into a ring shape for use from a state of extending along a linear path. Moreover, the arrangement can reduce the frictional force when the surface of the contact body 220 contacts the wafer, reducing damage to the wafer and lowering the defect rate during product manufacturing.

In one example, the shape of the contact assembly 200 is rectangular. The rectangular contact assembly 200 is easier to process, features a simple shape, resists deformation throughout processing, and can reduce waste during cutting, thereby reducing the processing cost and improving the processing efficiency and production performance.

In this embodiment, as shown in FIG. 6, the contact portion 222 is tilted relative to the horizontal plane and is inclined at an angle α of 6° to the horizontal plane. In other embodiments, the value of the included angle α can be in the range of $0-20^\circ$, which is flexibly selected according to the material of the contact portion 222. Simulation analysis is carried out on 306 stainless steel. Under different angles, the reaction force of a single contact portion 222 on the wafer is as follows: when α is 6° , the reaction force is 0.0339 N; when α is 12° , the reaction force is 0.0513 N; when α

is 15° , the reaction force is 0.0516 N; when α is 18° , the reaction force is 0.0520 N.

After the electroplating process is completed, the wafer tends to adhere to the contact assembly 200. In the present invention, the contact portions 222 are tilted relative to the horizontal plane. As the included angle α increases, the reaction force on the wafer also gradually increases, and the wafer is less prone to adhesion. However, if the tilt angle is excessive, placing the wafer on the contact portions 222 may result in scratching of the wafer. Therefore, the included angle α is controlled within 20° . By virtue of this arrangement, when the wafer contacts the contact portions 222, the wafer is less prone to being scratched by the contact portions 222; after deformation, the contact portions 222 can exhibit spring-back, which can prevent the wafer from adhering to the contact assembly 200 after the electroplating process is completed.

In this embodiment, the extending portions 221 and the mounting body 210 are in an arcuate transition. Traditional acute-angle connection tends to cause stress concentration, creating a risk of cracking or fracture at the junctions between the extending portions 221 and the mounting body 210. The arcuate transition adopted in this embodiment can reduce stress concentration, and reduce the occurrence of fatigue and deformation problems, thereby improving the service life of the contact assembly 200.

In addition, in other embodiments, the connection portion 214 may not be provided. The plurality of mounting portions 211 of the mounting body 210 may be connected to each other, or the plurality of extending portions 221 of the contact body 220 may be connected to each other.

After the structure of the contact assembly 200 of the present invention is clarified, the contact assembly can be processed using mature processes, such as wire-EDM and stamping hybrid process, and specific processing methods are not repeated herein.

Embodiment 2

This embodiment provides a chuck. The chuck is a significant part of semiconductor electroplating equipment. The central part of the chuck has accommodating space for holding a substrate, and the chuck is configured to hold the

substrate (not shown in the figures). In this embodiment, the substrate is a wafer, and the substrate may also be other workpiece structures that require electroplating.

Specifically, as shown in FIGS. 7 and 8, the chuck comprises an inner pressure ring 100, a frame 300, and the contact assembly 200 in embodiment 1. The contact assembly 200 is obtained by bending the rectangular contact assembly in FIG. 4 into a ring shape. The upper surface of the inner pressure ring 100 is provided with first mounting holes 110, and the frame 300 is provided with second mounting holes 320 corresponding to the first mounting holes 110. The contact assembly 200 is press-fitted against the frame 300 via the inner pressure ring 100, and the inner pressure ring 100 can be secured to the frame 300 via fasteners, thereby securing the contact assembly 200 to the frame 300.

Further, according to FIGS. 9 to 11, the inner peripheral surface of the frame 300 is provided with an annular groove 310, the guide portions 213 of the contact assembly 200 are disposed in the annular groove 310, and the mounting portions 211 are attached to and in close contact with the inner peripheral surface of the frame 300. Through the cooperation between the guide portions 213 and the annular groove 310, the contact assembly 200 can be guided to be bent into a ring shape along the annular groove 310, matching the inner peripheral surface of the frame 300. In addition, under the action of the inner pressure ring 100, the contact assembly 200 can be stably secured on the inner peripheral surface of the frame 300.

In other embodiments, the contact assembly 200 may first be bent into an arc shape, and then a plurality of arc-shaped contact assemblies are joined end-to-end to form a ring shape.

In this embodiment, as shown in FIG. 11, gaps are provided between the extending portions 221 of the contact body 220 and the inner peripheral surface of the frame 300. With the gap present, when the wafer is placed on the contact body 220, the contact body 220 will move toward the inner peripheral surface of the frame 300, which provides cushioning, enabling soft contact between the wafer and the contact body 220. Therefore, the wafer is less prone to fracture. Moreover, the contact body 220 will undergo elastic deformation within the gap, so that upon separation of the wafer from the contact body 220, the contact body 220 will produce a reaction force

that reduces wafer adhesion.

Embodiment 3

This embodiment further provides an electroplating apparatus, comprising the chuck in embodiment 2.

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

What is claimed is:

1. A contact assembly, extending along a linear path, comprising:

a mounting body, including a plurality of mounting portions arranged at intervals, the plurality of mounting portions being distributed along the length direction of the contact assembly, the adjacent mounting portions being separated by a first hollow area, and each mounting portion being provided with a guide portion protruding from the mounting body;

a contact body, provided with a plurality of second hollow areas distributed at intervals along the length direction of the contact assembly, and the contact body being connected to the mounting body for contacting a substrate.

2. The contact assembly according to claim 1, wherein the contact assembly further comprises a connection portion, the connection portion extends along the length direction of the contact assembly, and the connection portion includes a first end surface and a second end surface disposed opposite to each other; the first end surface is connected to the mounting body, and the mounting body extends outward from the first end surface along the width direction of the contact assembly; the second end surface is connected to the contact body, and the contact body extends outward from the second end surface along the width direction of the contact assembly.

3. The contact assembly according to claim 2, wherein the inner end surfaces of the first hollow areas extend to the first end surface, and/or the inner end surfaces of the second hollow areas extend to the second end surface.

4. The contact assembly according to claim 2, wherein the guide portions are disposed at the ends of the mounting portions away from the connection portion.

5. The contact assembly according to claim 1, wherein the shape of the contact assembly is rectangular.

6. The contact assembly according to claim 1, wherein the contact body includes a plurality of extending portions, the plurality of extending portions are distributed along the length direction of the contact assembly, the second hollow area is disposed

between the adjacent extending portions, the proximal end of each extending portion is connected to the mounting body, and the distal end of each extending portion is provided with a contact portion for contacting the substrate.

7. The contact assembly according to claim 6, wherein the contact portions are inclined relative to the horizontal plane, and each included angle with the horizontal plane is between 0° and 20°.

8. The contact assembly according to claim 6, wherein the extending portions and the mounting body are in an arcuate transition.

9. A chuck, for holding a substrate, comprising:

an inner pressure ring;

a frame;

the contact assembly according to any one of claims 1 to 8, each mounting portion of the contact assembly being attached to and in close contact with the inner peripheral surface of the frame, the inner peripheral surface of the frame being provided with an annular groove, each guide portion of the contact assembly being disposed in the annular groove, and the contact assembly being press-fitted against the inner peripheral surface of the frame via the inner pressure ring.

10. The chuck according to claim 9, wherein a gap is provided between the contact body of the contact assembly and the inner peripheral surface of the frame.

11. The chuck according to claim 10, wherein the contact body of the contact assembly includes a plurality of extending portions, the plurality of extending portions extend along the length direction of the mounting body, a second hollow area is disposed between the adjacent extending portions, the proximal end of each extending portion is connected to the mounting body, the distal end of each extending portion is provided with a contact portion for contacting the substrate, and gaps are provided between the extending portions and the inner peripheral surface of the frame.

12. An electroplating apparatus, comprising the chuck according to any one of

claims 9 to 11.