

PRESSURE MEMBRANE CAPABLE OF QUICKLY AND UNIFORMLY RESPONDING TO PRESSURE CHANGES

CROSS-REFERENCE TO RELATED APPLICATIONS

- 5 **[0000]** The present application claims the filing date of an earlier Chinese Invention Patent application Nr. 2024110234023 as its priority, which was filed on 29 July 2024. All contents or relevant information is hereby incorporated by reference partially and/or completely, wherever relevant or appropriate.

10 **TECHNICAL FIELD**

[0001] The present disclosure relates to the technical field of semiconductor chip processing, particularly to a pressure membrane capable of quickly and uniformly responding to pressure changes.

15 **BACKGROUND ART**

[0002] In the current semiconductor chip processing field, a polishing head is needed to polish a wafer. Pressure membrane is one of numerous components of the polishing head. By connecting gas to the components of the polishing head, the pressure membrane is controlled to load and unload the wafer, causing the wafer to rub on a polishing pad and achieving the
20 purpose of polishing. The existing pressure membrane, due to its excessively flat upper and lower surfaces, has insufficient pressure around its inner diameter, resulting in delayed local response and uneven force distribution when the pressure membrane adsorbs and unloads the wafer. This leads to uneven force distribution of the pressure membrane, and leads to uneven suction force in different areas of the wafer, resulting in uneven polishing effects. Areas with
25 excessive suction force are over polished, while areas with smaller suction force are under polished, seriously affecting the quality and yield of the wafer.

[0003] In addition, this uneven pressure can also lead to damage of the pressure membrane during operation, further increasing instability factors in the polishing process and reducing production efficiency and reliability of products. To address these issues, it is necessary to
30 improve and optimize the existing pressure membrane to enhance its performance and stability, ensuring the quality and consistency of wafer polishing.

SUMMARY

[0004] The purpose of the present disclosure is to provide a pressure membrane capable of quickly and uniformly responding to pressure changes. By changing structure of the pressure membrane, gas may be effectively guided to cover various areas of the pressure membrane, allowing the pressure membrane to quickly and uniformly respond to changes in gas pressure, reducing the impact of uneven pressure, ensuring consistency in the quality for polishing wafers, and further improving operational efficiency of enterprises.

[0005] In order to achieve the above objectives, the present disclosure provides a pressure membrane capable of quickly and uniformly responding to pressure changes. The pressure membrane is circular. The pressure membrane includes a circular bottom, a vertical portion, an extension portion, and a sealing edge. The vertical portion is arranged around a circumference of outer edge of the circular bottom. The vertical portion surrounds a circle along the circumference of the circular bottom. Inner side of the vertical portion and inner side of the circular bottom enclose an air chamber cavity. A circumference of top of the vertical portion is arranged with the extension portion. The extension portion is arranged perpendicular to the vertical portion and parallel to the circular bottom. The extension portion covers top of the air chamber cavity in a circular shape. A circumference of inner side of the extension portion is arranged with the sealing edge arranged perpendicular to the extension portion and parallel to the vertical portion. Upper surface of the circular bottom is arranged with convex points, and lower surface of the circular bottom is a flat surface.

[0006] In some embodiments, the vertical portion and the circular bottom are integrated molded. The vertical portion and the extension portion are also integrated molded. A connection position between the vertical portion and the circular bottom and a connection position between the vertical portion and the extension portion are arranged with rounding chamfers.

[0007] In some embodiments, the sealing edge and the extension portion are integrated molded.

[0008] In some embodiments, a lot of convex points are arranged, and the convex points are uniformly distributed on the upper surface of the circular bottom.

[0009] In some embodiments, the convex points form circular arrays and the circular arrays are uniformly distributed along an inner diameter of the upper surface of the circular bottom. A spacing between two adjacent circular arrays of the circular arrays is equal to a diameter of each of the convex points. An outermost circular array formed by the convex points arranged at the circular bottom is arranged 1 mm away from an edge of an inner diameter of the

circular bottom.

[0010] In some embodiments, the convex points are hemispherical, and a spacing between two adjacent convex points of one circular array is equal to the diameter of each of the convex points.

5 **[0011]** In some embodiments, the sealing edge is coaxially arranged inside the gas chamber cavity in a circular shape.

[0012] The advantages and positive effects of the pressure membrane capable of quickly and uniformly responding to pressure changes according to the present disclosure are as follows.

[0013] 1. The present disclosure arranges convex points on the flat surface of the pressure
10 membrane, and utilizes the principle of gas acceleration. By adding obstacles to the direction of gas movement, the gas will accelerate exponentially. As the flow area becomes smaller, the gas needs to pass through at a faster speed to ensure a same flow capacity with the upstream. The gas, gas pressure, interaction, and stress around each convex point are all the same to those of other convex point. Flow velocity of the bottom is faster, and the structure of the
15 convex point of the present disclosure is more conducive to separating from other components of the polishing head than the structure of original flat surface, achieving the purpose of quick response.

[0014] 2. The present disclosure adopts the rounding chamfers arranged at the connection
20 position between the vertical portion and the circular bottom and the connection position between the vertical portion and the extension portion. Compared with setting of the chamfer, the force surface of the rounding chamfer is smoother than the chamfer and more conducive to gas flow.

[0015] 3. In order to increase the overall airtightness of the pressure membrane, the present
25 disclosure adds a sealing edge at the original straight opening, and assembles the sealing edge more closely with other components of the polishing head to form a sealed structure, further preventing gas loss.

[0016] The technical solution of the present disclosure will be further described in detail through the accompanying drawings and embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a structural schematic diagram of the existing pressure membrane.

[0018] FIG. 2 is a structural schematic diagram of the pressure membrane of the present disclosure.

5 [0019] FIG. 3 is a schematic cross-sectional view of the pressure membrane of the present disclosure.

[0020] FIG. 4 is a schematic cross-sectional view of the sealing edge in the pressure membrane of the present disclosure.

[0021] FIG. 5 is a schematic diagram of the pressure membrane of the present disclosure
10 bearing gas pressure.

[0022] Reference numerals

[0023] 1. extension portion; 2. circular bottom; 3. convex point; 4. vertical portion; 5. sealing edge; 6. rounding chamfer; 7. air chamber cavity.

15 DETAILED DESCRIPTION OF THE EMBODIMENTS

[0024] The technical solution of the present disclosure is further explained through the accompanying drawings and embodiments.

[0025] Unless otherwise defined, the technical or scientific terms used in the present disclosure shall have the usual meanings as understood by those skilled in the art to which the
20 present disclosure belongs. The terms "first", "second" and similar terms used in the present disclosure do not indicate any order, quantity or importance, but are only used to distinguish different components. Terms such as "including" or "containing" mean that elements or objects appeared before the terms cover those and their equivalents listed after the terms, without excluding other elements or objects. Terms such as "connection" or "link" are not
25 limited to physical or mechanical connections, but may include electrical connections, whether direct or indirect. "Up", "down", "left", "right", and etc. are only used to represent relative positional relationships. When an absolute position of the described object changes, the relative positional relationships may also change accordingly.

[0026] Embodiments

30 [0027] A pressure membrane capable of quickly and uniformly responding to pressure changes is provided. The pressure membrane is circular, and includes a circular bottom 2, a vertical portion 4, an extension portion 1, and a sealing edge 5.

[0028] The vertical portion 4 is arranged around a circumference of outer edge of the circular bottom 2. The vertical portion 4 surrounds a circle along the circumference of the

circular bottom 2. Inner side of the vertical portion 4 and inner side of the circular bottom 2 enclose an air chamber cavity 7. A circumference of top of the vertical portion 4 is arranged with the extension portion 1. The extension portion 1 is arranged perpendicular to the vertical portion 4 and parallel to the circular bottom 2. The vertical portion 4 and the circular bottom 2 are integrated molded. The vertical portion 4 and the extension portion 1 are also integrated molded. The connection position between the vertical portion 4 and the circular bottom 2 and the connection position between the vertical portion 4 and the extension portion 1 are arranged with rounding chamfers 6.

[0029] The extension portion 1 covers top of the air chamber cavity 7 in a circular shape. A circumference of inner side of the extension portion 1 is arranged with the sealing edge 5 arranged perpendicular to the extension portion 1 and parallel to the vertical portion 4. The sealing edge 5 and the extension portion 1 are integrated molded. The sealing edge 5 is coaxially arranged inside the gas chamber cavity 7 in a circular shape.

[0030] As shown in FIGS. 2 to 3, upper surface of the circular bottom 2 is arranged with convex points 3, and lower surface of the circular bottom 2 is a flat surface. A lot of convex points 3 are arranged. The convex points 3 are uniformly distributed on the upper surface of the circular bottom 2. The convex points 3 form circular arrays and the circular arrays are uniformly distributed along an inner diameter of the upper surface of the circular bottom 2 circle by circle. A spacing between two adjacent circular arrays formed by convex points 3 is equal to a diameter of each of the convex points 3. An outermost circular array formed by the convex points 3 arranged at the circular bottom 2 is arranged 1 mm away from an edge of an inner diameter of the circular bottom 2. The convex points 3 are hemispherical. A spacing between two adjacent convex points 3 of the circular array is equal to the diameter of each of the convex points 3.

[0031] As shown in FIG. 1, the inner diameter of structure of the existing pressure membrane is a pure flat surface, which may withstand uneven gas pressure. The present disclosure utilizes the principle of gas acceleration, namely the flow continuity theorem. By adding obstacles to the direction of gas movement, the gas will accelerate exponentially. Because the flow area has decreased, gas needs to pass through at a faster speed to ensure the same flow capacity with the upstream. As shown in FIG. 5, the structure of the pressure membrane is optimized by utilizing this principle: the entire flat surface is covered with hemispherical obstacles, which may also be known as convex points 3. The gas, gas pressure, interaction, and stress around each convex point 3 are all the same to those of other convex point 3. Flow velocity of the bottom is faster, and the structure of the convex point 3 is more

conductive to separating from other components of the polishing head than the structure of the original flat surface, achieving the purpose of quick response. The size, spacing, uniform distribution, roughness of the surface, and flatness of the bottom of the convex points 3 are controlled by a mold, and the specific dimensions are determined according to the overall size ratio of the pressure membrane. The size of the convex point 3 is matched with the size of the wafer one by one. For example, a 6 cun (a traditional Chinese unit of length, approximately 3.33 cm) wafer corresponds to a convex point 3 with a diameter of 1 mm, a spacing of 1 mm, and a height of 0.5 mm.

[0032] As shown in FIG. 4, rounding chamfers 6 are arranged at the connection position between the vertical portion 4 and the circular bottom 2 and the connection position between the vertical portion 4 and the extension portion 1. Compared with setting of the chamfer, the force surface of the rounding chamfer is smoother and more conducive to gas flow. The specific size of the rounding chamfer 6 should be determined according to the overall size ratio of the pressure membrane, and the rounding chamfer 6 should with no burrs.

[0033] In order to increase the overall airtightness of the pressure membrane, a sealing edge 5 is added at the original flat opening. The sealing edge 5 is assembled more closely with other components of the polishing head to form a sealed structure, further preventing gas loss. The specific size of sealing edge 5 is suitable to match the size of components of the polishing head.

[0034] During loading a wafer, an air pump is connected to the polishing head, and gas is extracted from a gas path of the polishing head. In this case, interior of the pressure membrane is in a negative pressure state. Then the wafer is absorbed by the pressure membrane, and loading of the wafer is completed. During unloading the wafer, the polishing head is connected to the air pump, and gas enters the pressure membrane from the gas path of the polishing head. In this case, the pressure membrane is filled with gas and in a positive pressure state. Then the pressure membrane separates from the wafer, and unloading of the wafer is completed. During the process of loading or unloading the wafer, there are significant differences between two different structures of the pressure membrane, and results are as follows.

[0035] ① Regarding the pressure membrane with convex points of the present disclosure: during loading or unloading the wafer, the response of each area is consistent, and there is no additional delay in loading and unloading actions, time of the loading action and time of the unloading action each are a fixed time of 1.5 seconds.

[0036] ② Regarding the pressure membrane without convex points (structure of this pressure membrane is consistent with those of the present disclosure except for the absence of convex points): the response of each area is inconsistent, and there is an additional delay in each of loading and unloading actions. Time of the loading action and time of the unloading action each are 3-4.5 seconds.

[0037] Therefore, above pressure membrane capable of quickly and uniformly responding to pressure changes is adopted in the present disclosure. By changing structure of the pressure membrane, gas may be effectively guided to cover various areas of the pressure membrane, allowing the pressure membrane to quickly and uniformly respond to changes in gas pressure, reducing repeated polishing caused by uneven pressure or time and material costs caused by excessive polishing. The present disclosure can further extend the service life of the pressure membrane, and ensure the consistency of the quality for polishing wafers, and further improve the operational efficiency of the enterprises.

[0038] Finally, it should be noted that the above embodiments are only used to illustrate the technical solution of the present disclosure and not to limit it. Although the present disclosure has been described in detail with reference to the preferred embodiments, those skilled in the art should understand that modifications or equivalent substitutions can still be made to the technical solution of the present disclosure, and these modifications or equivalent substitutions cannot make the modified technical solution deviate from the spirit and scope of the technical solution of the present disclosure.

CLAIMS

1. A pressure membrane capable of quickly and uniformly responding to pressure changes, characterized in that: the pressure membrane is circular, comprising a circular bottom, a vertical portion, an extension portion, and a sealing edge, the vertical portion is arranged around a circumference of outer edge of the circular bottom, and the vertical portion surrounds a circle along the circumference of the circular bottom, inner side of the vertical portion and inner side of the circular bottom enclose an air chamber cavity, a circumference of top of the vertical portion is arranged with the extension portion, the extension portion is arranged perpendicular to the vertical portion and parallel to the circular bottom, the extension portion covers top of the air chamber cavity in a circular shape, and a circumference of inner side of the extension portion is arranged with the sealing edge arranged perpendicular to the extension portion and parallel to the vertical portion, upper surface of the circular bottom is arranged with convex points, and lower surface of the circular bottom is a flat surface;

the vertical portion and the circular bottom are integrated molded, and the vertical portion and the extension portion are also integrated molded, a connection position between the vertical portion and the circular bottom and a connection position between the vertical portion and the extension portion are arranged with rounding chamfers;

a lot of convex points are arranged, the convex points are uniformly distributed on the upper surface of the circular bottom; the convex points form circular arrays and the circular arrays are uniformly distributed along an inner diameter of the upper surface of the circular bottom, a spacing between two adjacent circular arrays of the circular arrays is equal to a diameter of each of the convex points, an outermost circular array formed by the convex points arranged at the circular bottom is arranged 1 mm away from an edge of an inner diameter of the circular bottom; the convex points are hemispherical, and a spacing between two adjacent convex points of one circular array is equal to the diameter of each of the convex points.

2. The pressure membrane capable of quickly and uniformly responding to pressure changes according to claim 1, characterized in that: the sealing edge and the extension portion are integrated molded.

3. The pressure membrane capable of quickly and uniformly responding to pressure changes according to claim 1, characterized in that: the sealing edge is coaxially arranged inside the gas chamber cavity in a circular shape.