

LINER ASSEMBLY, REACTION CHAMBER AND SEMICONDUCTOR PROCESSING APPARATUS

TECHNICAL FIELD

5 The present disclosure belongs to the field of semiconductor processing, and particularly relates to a liner assembly, a reaction chamber and a semiconductor processing apparatus.

BACKGROUND

10 A magnetron sputtering physical vapor deposition (PVD) apparatus includes a reaction chamber provided therein with a base configured to bear a workpiece to be processed. Moreover, a target is disposed above the base and in the reaction chamber, and is electrically connected with a radio frequency (RF) power supply to excite a process gas to generate plasma. In addition, a support assembly is disposed above the target, and forms a sealed chamber body, which is filled with deionized water, together with the target. A magnetron is further disposed
15 in the sealed chamber body, and is connected with a driving source outside the sealed chamber body, so as to scan the target under the action of the driving source.

 In a magnetron sputtering PVD process, a process gas is introduced into the reaction chamber, the RF power supply is turned on, the process gas is excited to generate plasma, the plasma bombards the target, and the metal atoms escaping from the target are deposited on the
20 workpiece to be processed. In addition, some of the metal atoms escaping from the target are deposited on an inner wall of the reaction chamber, resulting in contamination of the reaction chamber, which affects service life and use cost of the reaction chamber.

SUMMARY

25 According to one aspect of the present disclosure, a liner assembly is provided, and includes: a grounded liner ring, in which a plurality of shielding units are disposed at intervals along a circumferential direction of the liner ring, the plurality of shielding units being gaps which are formed between and penetrate an inner circumferential surface of the liner ring and an outer circumferential surface of the liner ring, and the gaps including a plurality of first
30 passages disposed at intervals in a direction from the inner circumferential surface toward the outer circumferential surface and a plurality of second passages each communicating two adjacent first passages; and orthographic projections of respective two first passages, which are adjacent to each other, on the inner circumferential surface of the liner ring are separated from

each other.

In some embodiments of the present disclosure, the liner ring includes at least two nesting sub-rings having different inner diameters, each of the sub-rings being grounded; with regard to the gaps, each first passage is a radial through hole correspondingly disposed in a respective sub-ring, and each second passage is an annular gap correspondingly disposed between
5 respective two sub-rings adjacent to each other.

In some embodiments of the present disclosure, a depth to width ratio of each gap satisfies:
 $B/A+C/D>5$

where A is a width of the radial through hole in a circumferential direction of the sub-ring;

10 B is a radial thickness of the sub-ring; C is a center distance between respective two radial through holes adjacent to each other in the same sub-ring; and D is a radial thickness of the annular gap.

In some embodiments of the present disclosure, a center distance between respective two radial through holes adjacent to each other in the same sub-ring is greater than or equal to 2mm.

15 In some embodiments of the present disclosure, a radial thickness of the sub-ring is less than or equal to 5mm.

In some embodiments of the present disclosure, a radial thickness of the annular gap is less than 10mm.

20 In some embodiments of the present disclosure, a width of the radial through hole in a circumferential direction of the sub-ring is in a range of 0.5mm to 10mm.

In some embodiments of the present disclosure, the number of the gaps is several tens.

In some embodiments of the present disclosure, the number of the gaps is greater than or equal to 60.

25 In some embodiments of the present disclosure, between respective two sub-rings adjacent to each other, each radial through hole in one sub-ring corresponds to an intermediate position between two radial through holes in the other sub-ring, the two radial through holes in the other sub-ring being adjacent to the radial through hole in the one sub-ring.

In some embodiments of the present disclosure, each radial through hole extends in an axial direction of the sub-ring.

30 In some embodiments of the present disclosure, each radial through hole penetrates through the sub-ring in the axial direction of the sub-ring.

According to another aspect of the present disclosure, a reaction chamber including a chamber body is provided, and the reaction chamber further includes:

a base disposed in the chamber body for carrying a workpiece to be processed;
a target disposed above the base and in the chamber body; and
the above liner assembly disposed at and surrounding an inner side of a sidewall of the chamber body.

- 5 In some embodiments of the present disclosure, the reaction chamber further includes:
a coil wound along an outer side of the sidewall of the chamber body; and
an RF power supply electrically connected to the coil.

In some embodiments of the present disclosure, a length of each gap in an axial direction of the liner ring is greater than an axial length of the coil, and an orthographic projection of the
10 coil on the outer circumferential surface of the liner ring is located between two ends of the gap in the axial direction of the liner ring.

According to another aspect of the present disclosure, a semiconductor processing apparatus including the above reaction chamber is provided.

The present disclosure has the following beneficial effects.

- 15 In the liner assembly of the present disclosure, the plurality of shielding units, that is, the gaps formed in the liner ring, are disposed at intervals along the circumferential direction of the liner ring, and the gaps include the plurality of first passages disposed at intervals in the direction from the inner circumferential surface toward the outer circumferential surface, and the orthographic projections of respective two first passages, which are adjacent to each other,
20 on the inner circumferential surface of the liner ring are separated from each other. In this way, when the liner assembly is applied to a reaction chamber, plasma can be prevented from passing through the gaps, so that a sidewall of the reaction chamber can be protected and be prevented from being contaminated.

The reaction chamber of the present disclosure adopts the above liner assembly, so that the
25 sidewall of the reaction chamber can be protected and be prevented from being contaminated.

The semiconductor processing apparatus of the present disclosure adopts the above reaction chamber, so that the sidewall of the reaction chamber can be protected and be prevented from being contaminated.

30 **BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other objectives, features and advantages of the present disclosure will become more apparent from the following description of the embodiments of the present disclosure with reference to the accompanying drawings. In the drawings:

Fig. 1 is a cross-sectional view of a liner assembly according to an embodiment of the present disclosure;

Fig. 2 is a radial section view of a liner assembly according to an embodiment of the present disclosure;

5 Fig. 3 is an enlarged view of Part P of Fig. 2;

Fig. 4 is a sectional structure diagram of a liner assembly along an axial direction thereof according to an embodiment of the present disclosure;

10 Fig. 5 is an unfolded plane illustrating orthographic projections of first passages of gaps of a liner assembly on an inner circumferential surface of a liner ring according to an embodiment of the present disclosure;

Fig. 6 is a cross-sectional view of a reaction chamber according to an embodiment of the present disclosure;

Fig. 7 is a cross-sectional view of another magnetron sputtering PVD apparatus; and

15 Fig. 8 is an unfolded plane illustrating orthographic projections of a coil and gaps of a reaction chamber on an outer circumferential surface of a liner ring according to an embodiment of the present disclosure.

Reference numerals:

20 1-chamber body; 11-upper sidewall; 12-lower sidewall; 13-bottom wall; 112-insulating cylinder; 14, 15, 18, 19-adapters;

2-auxiliary plasma excitation source; 21-coil; 22-RF power supply;

3-liner ring; 31-first sub-ring; 32-second sub-ring; 301A-first radial through hole, 302A-second radial through hole; 30-gap; 33-plane; 331, 332-areas; 34-connector; 35-upper liner; 36-middle liner; 37-lower liner;

25 4-plasma excitation source; 5-support assembly; 6-deionized water; 7-target; 8-magnetron; 9-drive device; 10-base; 20-workpiece to be processed; 16-RF power supply; 17-pressing ring; P-part.

DETAILED DESCRIPTION

30 To make the objectives, technical solutions and advantages of the present disclosure more apparent, the present disclosure will be further described in detail below with reference to the specific embodiments and the drawings.

An embodiment of the present disclosure provides a liner assembly including a grounded

liner ring 3 as shown in Fig. 1. In this embodiment, the liner ring 3 has a split structure, and specifically includes two nesting sub-rings having different inner diameters, namely a first sub-ring 31 and a second sub-ring 32 that surrounds the first sub-ring 31, and both the first sub-ring 31 and the second sub-ring 32 are grounded through a connector 34. For example, the first sub-ring 31 and the second sub-ring 32 are circular rings, and have an annular gap formed therebetween.

It should be noted that the Z direction in Fig. 1 is an axial direction of each sub-ring; and the X-Y plane is a plane parallel to a radial section of each sub-ring.

With reference to Figs. 2 and 3, a plurality of shielding units are disposed in the liner ring 3 at intervals along a circumferential direction thereof, each shielding unit is a gap 30 which is formed between and penetrates an inner circumferential surface (i.e., an inner circumferential surface of the first sub-ring 31) and an outer circumferential surface (i.e., an outer circumferential surface of the second sub-ring 32), and the gaps 30 include a plurality of first passages disposed at intervals in a direction from the inner circumferential surface toward the outer circumferential surface and a plurality of second passages each communicating two adjacent first passages. In this embodiment, with regard to the gaps 30, the first passages are radial through holes disposed in the sub-rings, and are specifically a plurality of first radial through holes 301A disposed in the first sub-ring 31 and a plurality of second radial through holes 302A disposed in the second sub-ring 32. The second passages are annular gaps disposed between respective two sub-rings adjacent to each other, that is, the gaps between an outer circumferential surface of the first sub-ring 31 and an inner circumferential surface of the second sub-ring 32. The first radial through holes 301A communicate with the second radial through holes 302A through the annular gaps, so that the first radial through holes 301A, the annular gaps, and the second radial through holes 302A form the gaps 30 capable of allowing feeding of RF energy.

Fig. 4 only shows the first radial through holes 301A according to this embodiment. As shown in Fig. 4, each first radial through hole 301A is a strip-shaped straight through hole, a length direction of which is set along the Z direction, that is, the first radial through hole 301A extends along an axial direction of the first sub-ring 31. In this way, the space occupied by a single radial through hole in a circumferential direction of a sub-ring is reduced, which allows the addition of more radial through holes in the sub-ring. In practical applications, the length direction may also be set to form an angle with the Z direction. In addition, instead of the straight through holes, the through holes in other shapes can be adopted, such as tapered holes.

The shape and/or size of each second radial through hole 302A may be the same as or different from those/that of the first radial through hole 301A.

Optionally, the first radial through holes 301A penetrate through one end of the first sub-ring 31 in the axial direction thereof.

5 As shown in Fig. 5, a plane 33 is an unfolded plane of the inner circumferential surface of the liner ring (i.e., the inner circumferential surface of the first sub-ring 31). With regard to the gaps 30, orthographic projections of respective two first passages, which are adjacent to each other, on the inner circumferential surface of the liner ring (i.e., the inner circumferential surface of the first sub-ring 31) are separated from each other. Specifically, an orthographic projection (shown by a dotted line in Fig. 5) of each first radial through hole 301A and an
10 orthographic projection (shown by a solid line in Fig. 5) of any one of the second radial through holes 302A are separated from each other on the plane 33, so that the gaps 30 constitute a labyrinthine structure. Thus, when the liner assembly is applied to a reaction chamber, the gaps 30 can prevent plasma from passing through the gaps 30 with the labyrinthine structure, besides
15 ensuring the feeding of RF energy, thereby protecting a sidewall of the reaction chamber against contamination.

It should be noted that the orthographic projections of respective two first passages, which are adjacent to each other, on the inner circumferential surface of the liner ring 30 (i.e., the inner circumferential surface of the first sub-ring 31, the unfolded surface of which is the plane
20 33) are separated from each other in this embodiment. In this embodiment, the positional relation between respective two first passages adjacent to each other is only illustrated by taking the inner circumferential surface of the liner ring as a reference plane. But any other reference plane such as the outer circumferential surface of the liner ring 30 can be used to indicate such positional relation.

25 It should be noted that the liner ring 3 in this embodiment has a split structure, that is, is composed of a plurality of sub-rings. However, the present disclosure is not limited thereto. In practical applications, the liner ring 3 may also be formed into an integral structure, that is, is composed of a single ring body alone; with regard to the gaps 30, all of the first and second passages are disposed in the single ring body. In this case, the second passages are no longer the
30 annular gaps between respective two sub-rings adjacent to each other, but are non-annular passages each disposed between respective two first passages adjacent to each other, and the non-annular passages only need to make the two adjacent first passages communicate with each other, besides ensuring the integral structure of the liner ring 3.

The above description is merely for illustration, and the present embodiment is not limited thereto. The number of the sub-rings may be greater than two. The sub-rings are nested within one another and have different inner diameters.

With reference to Fig. 3, a depth to width ratio of each gap 30 satisfies:

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$$B/A+C/D>5$$

where A is a width of a radial through hole in a circumferential direction of a sub-ring (taking the first radial through hole 301A as an example); B is a radial thickness of a sub-ring (taking the second sub-ring 32 as an example); C is a center distance between respective two radial through holes adjacent to each other in the same sub-ring (taking the first radial through
10 holes 301A as an example); and D is a radial thickness of an annular gap (a radial distance between the outer circumferential surface of the first sub-ring 31 and the inner circumferential surface of the second sub-ring 32).

The depth to width ratio of the gap 30 defined as $B/A+C/D$ determines the capability of the gap 30 to prevent the penetration of metal atoms. By setting the depth to width ratio to be
15 greater than 5, it can be ensured that the metal atoms are successfully blocked by the gap 30.

With regard to the radial thickness B of the sub-ring, the thicker the sub-ring, the heavier the liner ring 3, the smaller the inner diameter of the reaction chamber, therefore, the thickness B may be set to be less than or equal to 5mm, so as to prevent the liner ring 3 from being too heavy and prevent the inner diameter of the reaction chamber from being too small.

20 With regard to the radial thickness D of the annular gap, considering that the plasma can easily enter the gap between the first sub-ring 31 and the second sub-ring 32 when the thickness D is too large, the thickness D may be set to be less than 10mm to reduce the probability of the plasma entering the gap between the first sub-ring 31 and the second sub-ring 32.

25 With regard to the width A of the radial through hole in the circumferential direction of the sub-ring, the smaller the width A is, the more difficult it is for the metal atoms to pass through the radial through hole, therefore, the width A may be set to be less than 10mm, and may be as small as 0.5mm.

The center distance C between respective two radial through holes adjacent to each other in the same sub-ring is related to the number of the radial through holes in such sub-ring. The
30 larger the distance C is, the greater the depth to width ratio of the gap 30 is, and the more difficult it is for the metal atoms to pass through the gap 30. However, if the distance C is too large, the number of the radial through holes in the same sub-ring will be affected. Thus, the distance C may be set to be greater than or equal to 2mm so as to not only block the metal

atoms but also satisfy the requirement of the number of the radial through holes.

Optionally, the number of the gaps 30, that is, the number of the radial through holes in the same sub-ring, is several tens, preferably not less than 60, so as to ensure sufficient feeding of RF energy.

5 In practical applications, the radial through holes in different sub-rings may be the same in number, or may not. In the case where the radial through holes in the different sub-rings are the same in number, between respective two sub-rings adjacent to each other, each radial through hole in one sub-ring corresponds to an intermediate position between two radial through holes in the other sub-ring, the two radial through holes in the other sub-ring being adjacent to the
10 radial through hole in the one sub-ring. Specifically, as shown in Fig. 3, each first radial through hole 301A in the first sub-ring 31 corresponds to an intermediate position between two second radial through holes 302A in the second sub-ring 32, the two second radial through holes 302A being adjacent to the first radial through hole 301A. In this way, the paths along which the RF energy passes through the gaps can be the same, and the plurality of gaps 30 can
15 be uniformly distributed along the circumferential direction of the liner ring 3, so as to ensure uniform feeding of RF energy.

Another embodiment of the present disclosure provides a reaction chamber. As shown in Fig. 6, the reaction chamber includes a chamber body 1, a base 10 disposed in the chamber body 1 for carrying a workpiece 20 to be processed, a target 7 disposed above the base 10 and
20 in the chamber body 1, and the liner assembly provided by the above embodiment.

For example, the reaction chamber in this embodiment can be applied to a magnetron sputtering PVD apparatus.

The liner assembly is disposed at and surrounds an inner side of a sidewall of the chamber body 1, and is configured to prevent the metal atoms escaping from the target 7 from being
25 deposited on the sidewall of the reaction chamber.

In this embodiment, the sidewall of the chamber body 1 includes an upper sidewall 11, a lower sidewall 12 and a bottom wall 13, the upper sidewall 11 and the lower sidewall 12 are disposed apart from each other in an axial direction of the chamber body 1, and have an insulating cylinder 112 disposed therebetween.

30 The reaction chamber further includes an upper electrode assembly, which includes a plasma excitation source 4, a magnetron 8, and a support assembly 5. The plasma excitation source 4 is configured to excite a process gas to generate plasma. The magnetron 8 is connected to a drive device 9. The target 7 is fixed to a bottom end of the support assembly 5, and the

support assembly 5 and the target 7 form a sealed chamber suitable to contain deionized water 6. The magnetron 8 is located in the sealed chamber and is connected to the drive device 9 outside the sealed chamber. A pressing ring 17 is further disposed around the workpiece 20 to be processed for fixing the workpiece 20 to be processed at the position thereof on the base 10.

5 The base 10 further applies RF power using an RF power supply 16. Under a negative bias of the base 10, the plasma can bombard a bottom of a deep hole in the workpiece 20 to be processed at an accelerated rate, so that part of the metal which has been deposited at the bottom is deposited on a sidewall of the deep hole, thereby improving the coverage of the sidewall of the deep hole.

10 In the liner assembly provided in this embodiment, a top end of the first sub-ring 31 is fixed to the upper sidewall 11 through an adapter 15 and is grounded through the upper sidewall 11, and a top end of the second sub-ring 32 is fixed to the upper sidewall 11 through an adapter 14 and is grounded through the upper sidewall 11. The sub-ring may be fixed to the adapter with screws. A bottom end of the second sub-ring 32 is bent inwards and extends to the
15 periphery of the base 10, so as to prevent metal atoms from being deposited on the bottom wall 13 of the chamber body 1.

Fig. 7 shows another reaction chamber provided therein with an upper liner 35, a middle liner 36 and a lower liner 37, and the upper liner 35 and the lower liner 37 are fixed to a
20 sidewall of the reaction chamber through two adapters 18 and 19, respectively. A slot is formed in the middle liner 36 to enable the energy from a coil 21 to be efficiently coupled into the reaction chamber. Due to the slot, metal atoms can penetrate through the middle liner 36 and be deposited on an insulating cylinder 112 in the reaction chamber, resulting in contamination of the sidewall of the reaction chamber. In addition, the middle liner 36 is set to have a floating potential and needs to be insulated from the upper liner 35 and the lower liner 37 by insulators.
25 The metal atoms may be deposited on the insulators as well, which deprives the insulators of the insulating function thereof, and reduces the energy coupling efficiency of the coil.

Relative to the reaction chamber shown in Fig. 7, the reaction chamber provided in this embodiment adopts the liner assembly of the present disclosure, so that the sidewall of the reaction chamber can be protected. When a process is performed in the reaction chamber, metal
30 atoms are deposited on the first passages when passing through the gaps 30, rather than being deposited on the insulating cylinder on the sidewall of the reaction chamber, so that the sidewall of the reaction chamber is prevented from being contaminated. Moreover, the liner assembly is grounded, so there is no need to set the liner assembly to have a floating potential and insulate

the liner assembly from other parts. In comparison with the liner assembly having a segmented structure and a floating potential in the prior art, the liner assembly of the present disclosure simplifies the structure and manufacturing process of the reaction chamber, and saves equipment cost.

5 In this embodiment, the coil 21 of the reaction chamber and an RF power supply 22 form an auxiliary plasma excitation source. The coil 21 is wound along an outer side of the sidewall of the chamber body 1. Specifically, for example, the coil 21 is wound along an outer side of the insulating cylinder 112 and is electrically connected to the RF power supply 22.

10 In this embodiment, the coil 21 may be formed from a spirally wound coil of one or more turns, and is configured to couple the RF power supplied by the RF power supply 22 into the chamber body 1 through the insulating cylinder 112. As a part of the chamber body 1, the insulating cylinder 112 is configured to achieve a high vacuum degree inside the chamber body 1 and allow the energy from the coil 21 to be coupled into the chamber body 1.

15 In a process, when a process gas such as argon is introduced into the chamber body 1, in addition to the plasma excitation source 4 of the upper electrode assembly which can excite the process gas to generate plasma, the energy from the coil 21 can also excite argon to generate second plasma after being coupled into the chamber body 1 through the insulating cylinder 112 and the liner assembly. Under a negative bias of the base 10, the second plasma bombards a film at a bottom of a deep hole in the workpiece 20 to be processed at an accelerated rate, so
20 that part of the metal which has been deposited at the bottom of the deep hole is deposited on two sidewalls of the deep hole, thereby improving the coverage of the sidewall of the deep hole.

In this embodiment, since each gap in the liner assembly has a function of blocking plasma, it is possible to dispose a relatively large number of gaps as long as the gaps can achieve protecting the sidewall of the reaction chamber. With the large number of gaps, the eddy
25 current loss caused by the liner assembly can be greatly reduced, and it can be ensured that more of the energy from the coil 21 can enter the chamber body 1 of the reaction chamber even if the liner assembly includes a plurality of sub-rings and is grounded, thereby improving the energy coupling efficiency. Furthermore, the energy coupling efficiency can be kept unchanged, and will not decrease when the process is performed.

30 For the liner assembly in the reaction chamber, the width A of the radial through hole in the circumferential direction of the sub-ring and the center distance C between respective two radial through holes adjacent to each other in the same sub-ring can be set to different values according to different materials of the target. The targets of different materials have different

coefficients of viscosity and thus differ in the capability of passing through the gaps 30, and the metal atoms having a lower coefficient of viscosity can pass through the gaps 30 more easily and be deposited on the insulating cylinder 112. Taking tantalum (Ta) as an example, since Ta has a very low coefficient of viscosity, the width A should be less than 2mm, and the distance C should be greater than 20mm. Copper has a higher coefficient of viscosity than Ta, so the width A should be less than 5mm and the distance C should be greater than 10mm.

In this embodiment, a material of the liner assembly may be a metal material such as Al or stainless steel. As shown in Fig. 8, the plane 33 is the unfolded plane of the inner circumferential surface of the liner ring (i.e., the inner circumferential surface of the first sub-ring 31). An orthographic projection of the coil 21 on the plane 33 is located in an area 332, and the orthographic projections of the first radial through holes 301A in the first sub-ring 31 and those of the second radial through holes 302A in the second sub-ring 32 on the plane 33 are located in an area 331. A length of each radial through hole in the axial direction of each sub-ring is greater than an axial length of the coil 21, and the orthographic projection of the coil 21 on the plane 33 is located between two ends of each radial through hole in the axial direction of the sub-ring. Thus, the eddy current loss caused by the liner assembly can be reduced, and the energy coupling efficiency can be improved.

The above description is merely for illustration, and this embodiment is not limited thereto. In the case where the liner assembly of the reaction chamber includes more than two liners, all of the liners are grounded by being fixed to an upper cylinder through corresponding adapters.

Still another embodiment of the present disclosure provides a semiconductor processing apparatus, which may be, for example, a magnetron sputtering PVD apparatus. The semiconductor processing apparatus includes the reaction chamber provided in the above embodiment, and is used for the manufacture of materials and films of Cu, Ta, Ti, Al, and the like.

It should be noted that the terms used in the embodiments to indicate directions, such as “upper”, “lower”, “front”, “back”, “left” and “right”, only indicate the directions with reference to the drawings, and are not intended to limit the protection scope of the present disclosure. The same elements are represented by the same or similar reference numerals throughout the drawings. Conventional structures or configurations are omitted when a misunderstanding of the present disclosure may be caused.

The shapes and sizes of the components in the drawings do not reflect actual sizes and proportions, but are merely for the illustration of the embodiments of the present disclosure.

Furthermore, any reference numeral in parentheses in the claims shall not be considered as limitation to the claims.

Unless otherwise indicated, numerical parameters provided in the description and appended claims are approximations that may vary according to the required properties obtained by the present disclosure. Specifically, it should be understood that all the numbers representing content of components or reaction conditions in the description and claims are modified by the word “about” in all circumstances. In general, the numbers mean that variations of a specified number by $\pm 10\%$, $\pm 5\%$, $\pm 1\%$, or $\pm 0.5\%$ in some embodiments are included.

Furthermore, the word “include” does not exclude an element or a step that is not listed in the claims. The word “a” or “an” before an element does not exclude that there are a plurality of such elements.

Ordinal numbers in the description and claims, such as “first”, “second” and “third”, are intended to modify corresponding elements, but do not imply or indicate that the modified element has any ordinal number. Furthermore, the ordinal numbers do not indicate an order of the elements or an order of the manufacturing processes of the elements, but are only intended to distinguish between two elements having the same name.

Similarly, it should be understood that, in order to simplify the present disclosure and help understand one or more aspects of the present disclosure, the technical features of the present disclosure are sometimes grouped together in a single embodiment, drawing, or description thereof in the above description of the exemplary embodiments of the present disclosure. However, the method of the present disclosure should not be interpreted as reflecting the intention that the claimed disclosure requires more features than those explicitly recorded in each claim. More precisely, as reflected in the following claims, a disclosed aspect is less than all the technical features of the previously disclosed single embodiment. Therefore, the claims according to the detailed description hereby are explicitly incorporated into the detailed description, with each claim itself being regarded as a single embodiment of the present disclosure.

The objectives, technical solutions and beneficial effects of the present disclosure are further illustrated in detail by the above specific embodiments. However, it should be understood that what is described above is only specific embodiments of the present disclosure, and is not intended to limit the present disclosure. Any modification, equivalent, and improvement made within the spirit and principle of the present disclosure should be included within the protection scope of the present disclosure.

CLAIMS

1. A liner assembly, comprising:

a grounded liner ring, in which a plurality of shielding units are disposed at intervals along a circumferential direction of the liner ring, the plurality of shielding units being gaps which are formed between and penetrate an inner circumferential surface of the liner ring and an outer circumferential surface of the liner ring, and the gaps comprising a plurality of first passages disposed at intervals in a direction from the inner circumferential surface toward the outer circumferential surface and a plurality of second passages each communicating two adjacent first passages; orthographic projections of respective two first passages, which are adjacent to each other, on the inner circumferential surface of the liner ring are separated from each other; and the gaps constitute a labyrinthine structure, so as to protect a sidewall of a reaction chamber.

2. The liner assembly of claim 1, wherein the liner ring comprises at least two nesting sub-rings having different inner diameters, each of the sub-rings being grounded; with regard to the gaps, each first passage is a radial through hole correspondingly disposed in a respective sub-ring, and each second passage is an annular gap correspondingly disposed between respective two sub-rings adjacent to each other.

3. The liner assembly of claim 2, wherein a depth to width ratio of each gap satisfies:

$$B/A+C/D>5$$

where A is a width of the radial through hole in a circumferential direction of the sub-ring; B is a radial thickness of the sub-ring; C is a center distance between respective two radial through holes adjacent to each other in the same sub-ring; and D is a radial thickness of the annular gap.

4. The liner assembly of claim 2, wherein a center distance between respective two radial through holes adjacent to each other in the same sub-ring is greater than or equal to 2mm.

5. The liner assembly of claim 2, wherein a radial thickness of the sub-ring is less than or equal to 5mm.

6. The liner assembly of claim 2, wherein a radial thickness of the annular gap is less than 10mm.

7. The liner assembly of claim 2, wherein a width of the radial through hole in a circumferential direction of the sub-ring is in a range of 0.5mm to 10mm.

8. The liner assembly of any one of claims 1 to 7, wherein the number of the gaps is several tens.

9. The liner assembly of claim 8, wherein the number of the gaps is greater than or equal to 60.

10. The liner assembly of claim 2, wherein, between respective two sub-rings adjacent to each other, each radial through hole in one sub-ring corresponds to an intermediate position between two radial through holes in the other sub-ring, the two radial through holes in the other sub-ring being adjacent to the radial through hole in the one sub-ring.

11. The liner assembly of claim 2, wherein each radial through hole extends in an axial direction of the sub-ring.

12. The liner assembly of claim 11, wherein each radial through hole penetrates through the sub-ring in the axial direction of the sub-ring.

13. A reaction chamber comprising a chamber body, further comprising:
a base disposed in the chamber body for carrying a workpiece to be processed;
a target disposed above the base and in the chamber body; and
the liner assembly of any one of claims 1 to 12, which is disposed at and surrounds an inner side of a sidewall of the chamber body.

14. The reaction chamber of claim 13, further comprising:
a coil wound along an outer side of the sidewall of the chamber body; and
a radio frequency power supply electrically connected to the coil.

15. The reaction chamber of claim 14, wherein a length of each gap in an axial direction

of the liner ring is greater than an axial length of the coil, and an orthographic projection of the coil on the outer circumferential surface of the liner ring is located between two ends of the gap in the axial direction of the liner ring.

16. A semiconductor processing apparatus, comprising the reaction chamber of any one of claims 13 to 15.