

# PROCESS CHAMBER OF SEMICONDUCTOR PROCESSING DEVICE AND SEMICONDUCTOR PROCESSING DEVICE

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## TECHNICAL FIELD

[0001] The present disclosure relates to the field of semiconductor manufacturing, and in particular, to a process chamber of a semiconductor processing device and a semiconductor processing device.

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## BACKGROUND

[0002] In the field of semiconductor manufacturing, a High-k Metal Gate (HKMG) process is widely applied to production of very large-scale integrated circuits. When fabricating a metal gate with the HKMG process, large aspect ratio and high step coverage are required in metal film hole filing, and the step coverage is usually required to be more than 60%. If a  
15 Chemical Vapor Deposition (CVD) process is selected to form a metal layer, when forming a metal portion of a gate stack structure, residual particles from an organometallic precursor may contaminate an underlying dielectric layer and thus affect dielectric properties of the gate dielectric layer. The conventional Direct Current (DC) power Physical Vapor Deposition (PVD) technology has low plasma ionization rate and low step coverage, and  
20 often cannot meet the process requirements.

[0003] At present, the PVD technology with simultaneously coupled Radio Frequency (RF) power and DC power is mainly adopted for deposition of a metal film of a metal gate. With the introduction of the RF power, higher plasma ionization rate and higher step coverage can be realized, and the process requirements can be met. However, the introduction of the RF  
25 power affects plasma uniformity, resulting in higher requirements on RF shielding and RF current distribution in a chamber. The RF can easily cause arcing in the chamber during a process, which affects performance of a deposited film, produces particles, and/or affects process uniformity. Thus, safety risk and manufacturing cost of the process are greatly increased, and a significant challenge is posed to device stability.

[0004] Therefore, how to avoid arcing in a process chamber of a semiconductor processing device after the introduction of the RF power is an urgent technical problem to be solved by those of ordinary skill in the art.

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## SUMMARY

[0005] In order to solve at least one of the technical problems in the prior art, the present disclosure provides a process chamber of a semiconductor processing device and a semiconductor processing device, which can avoid arcing in a process chamber.

[0006] For achieving the objective of the present disclosure, there is provided a process chamber of a semiconductor processing device, including a process chamber body, a base, a protective shield, and a grounding device; wherein

the base is movably disposed in the process chamber body, and is configured to support a wafer;

the protective shield is disposed around an inner sidewall of the process chamber body, and is configured to protect the inner sidewall of the process chamber body; and

the grounding device includes a first connector, a second connector, and a connecting spring, the first connector is connected to the base, the second connector is connected to the first connector through the connecting spring, and the second connector is capable of being attached to the protective shield when the base is raised to a processing position, so as to electrically connect the base to the protective shield.

[0007] In some embodiments, the connecting spring, the first connector, and the second connector are all ring-shaped and disposed around an axis of the base, the first connector and the second connector are connected to two ends of the connecting spring respectively, and an upper surface of the second connector is configured to be attached to a lower end of the protective shield.

[0008] In some embodiments, the first connector is ring-shaped and disposed about an axis of the base, and an upper end of the first connector is configured to be connected to the base; and

one end of the connecting spring is fixedly connected to an outer circumferential surface of the first connector, the other end of the connecting spring is fixedly connected to the second connector, and the connecting spring is configured to support the second connector to be attached to an inner side surface of the protective shield.

[0009] In some embodiments, the first connector includes a first connecting ring, a second connecting ring, and a third connecting ring, the first connecting ring and the third connecting ring are located at an upper end and a lower end of the second connecting ring respectively, and the first connecting ring is configured to be connected to the base; and

5 one end of the connecting spring is fixedly connected to an outer circumferential surface of the third connecting ring.

[0010] In some embodiments, the second connector has a convex curved surface, which is configured to be attached to the inner side surface of the protective shield.

[0011] In some embodiments, the first connector further includes a fixing member, which  
10 has a first surface and a second surface opposite to each other, dimensions of the first surface and the second surface in an axial direction of the third connecting ring are greater than an axial dimension of the third connecting ring, the first surface is fixedly connected to the outer circumferential surface of the third connecting ring, and the second surface is fixedly connected to the connecting spring.

15 [0012] In some embodiments, the first connector is ring-shaped and disposed about an axis of the base, and an upper end of the first connector is configured to be connected to the base; and an outer circumferential surface of the first connector is provided with a flange; and

the connecting spring is disposed on the flange, one end of the connecting spring is connected to an upper surface of the flange, the other end of the connecting spring is fixedly  
20 connected to the second connector, and the connecting spring is configured to support the second connector to be attached to a lower end of the protective shield.

[0013] In some embodiments, the first connector includes a first connecting ring, a second connecting ring, and a third connecting ring, the first connecting ring and the third connecting ring are located at an upper end and a lower end of the second connecting ring  
25 respectively, and the first connecting ring is configured to be connected to the base; and

an edge portion of the third connecting ring protrudes relative to an outer circumferential surface of the second connecting ring, and the protruding portion is the flange.

[0014] In some embodiments, a number of connecting springs is more than one, the connecting springs are uniformly distributed along a circumferential direction of the first  
30 connector, a number of second connectors is the same as the number of the connecting springs, and the second connectors are connected to the connecting springs in a one-to-one correspondence.

[0015] In some embodiments, a number of connecting springs is more than one, the connecting springs are uniformly distributed along a circumferential direction of the first connector, the second connector is ring-shaped and disposed around the axis of the base, and the second connector is fixedly connected to the other end of each connecting spring.

5 [0016] In some embodiments, the process chamber further includes a lifting shaft and a bellows assembly, wherein

an upper end of the lifting shaft is connected to a bottom of the base, a lower end of the lifting shaft penetrates through a bottom of the process chamber body, and extends to the outside of the process chamber body, and the lifting shaft is configured to drive the base to  
10 rise and fall; and

the bellows assembly includes a first mounting plate, a second mounting plate, and a bellows, the bellows is sleeved outside the lifting shaft, the first mounting plate and the second mounting plate are located at an upper end and a lower end of the bellows respectively, the first mounting plate is hermetically connected to the base, the second mounting plate is  
15 disposed around the lifting shaft, and is hermetically connected to a bottom surface of the process chamber body, and the first connector is fixedly connected to the first mounting plate.

[0017] In some embodiments, the protective shield is cylindrical and has an upward folded part at a lower end of the protective shield, and an inner peripheral surface of the folded part or a lower end surface of the protective shield form a contact surface for establishing  
20 electrical connection by contact with the second connector.

[0018] In the other technical solution, the present disclosure further provides a semiconductor processing device, including a process chamber and an upper electrode mechanism disposed above the process chamber, the process chamber being the process chamber provided herein.

25 [0019] The present disclosure has the following beneficial effects:

the process chamber of the semiconductor processing device provided herein includes the process chamber body, the base, the protective shield, and the grounding device; and the base is movably disposed in the process chamber body, and is configured to support the wafer, the protective shield is disposed around the inner sidewall of the process chamber body, and  
30 is configured to protect the inner sidewall of the process chamber body, the grounding device includes the first connector, the second connector, and the connecting spring, the first connector is connected to the base, the second connector is connected to the first connector through the connecting spring, and the second connector is capable of being attached to the

protective shield when the base is raised to the processing position, so as to electrically connect the base to the protective shield. The first connector is electrically connected to the base, and the connecting spring supports the second connector to be attached to the protective shield when the base is raised to the processing position, so that electrical connection  
5 between the base and the protective shield is achieved to keep the base and the protective shield at a same potential, and the base can be grounded through the protective shield and the process chamber body in sequence, which avoids arcing between the base and the protective shield. In addition, the connecting spring can extend and compress many times without being damaged, so that a service life of the grounding device is prolonged.

10 [0020] By adopting the process chamber provided herein, the semiconductor processing device provided herein avoids arcing between the base and the protective shield.

## BRIEF DESCRIPTION OF DRAWINGS

[0021] FIG. 1 is a schematic structural diagram of a semiconductor processing device  
15 according to an implementation of the present disclosure;

[0022] FIG. 2 is a schematic structural diagram illustrating a case where a grounding device in FIG. 1 cooperates with a protective shield when the grounding device is not in operation;

[0023] FIG. 3 is a schematic structural diagram illustrating a case where the grounding device in FIG. 1 cooperates with the protective shield when the grounding device is in operation;

20 [0024] FIG. 4 is a schematic structural diagram of the grounding device in FIG. 2;

[0025] FIG. 5 is a schematic structural diagram illustrating a case where a grounding device cooperates with a protective shield when the grounding device is not in operation according to another implementation of the present disclosure;

[0026] FIG. 6 is a schematic structural diagram illustrating a case where the grounding device  
25 in FIG. 5 cooperates with the protective shield when the grounding device is in operation;

[0027] FIG. 7 is a schematic structural diagram illustrating a case where a grounding device cooperates with a protective shield when the grounding device is not in operation according to yet another implementation of the present disclosure; and

[0028] FIG. 8 is a schematic structural diagram illustrating a case where the grounding device  
30 in FIG. 7 cooperates with the protective shield when the grounding device is in operation.

[0029] Reference numerals in FIG. 1 to FIG. 8 are as follows:

target 10, wafer 20, upper electrode mechanism 100, RF power supply 101, first RF matcher 102, DC power supply 103, upper electrode metal housing 104, metal sleeve 105, target backing plate 106, magnetron mounting plate 107, magnet 108, rotating shaft 109, ceramic ring 110, process chamber body 200, protective kits 300, protective shield 301, cover ring 302, deposition ring 303, base 400, supporting member 401, cooling plate 402, bellows assembly 500, first mounting plate 501, bellows 502, second mounting plate 503, lifting shaft 600, second RF matcher 700, grounding device 800, first connector 810, first connecting rings 811a, 811b, 811c, connection holes 812a, 812b, 812c, second connecting rings 813a, 813b, third connecting rings 814a, 814b, flange 814b1, fixing member 815, connecting springs 820, 820a, 820b, 820c, second connector 830, grounding ring 831, hemispherical metal component 832, and connecting metal component 833.

## DETAIL DESCRIPTION OF EMBODIMENTS

[0030] In order to enable those of ordinary skill in the art to better understand the technical solutions of the present disclosure, a process chamber of a semiconductor processing device provided in the present disclosure will be described in detail below with reference to the drawings.

[0031] Referring to FIG. 1, an embodiment of the present disclosure provides a semiconductor processing device, including a target 10, an upper electrode mechanism 100, and a process chamber. An embodiment of the present disclosure further provides a process chamber, which is applicable to the semiconductor processing device provided in the embodiment of the present disclosure. The process chamber includes a process chamber body 200, a base 400, protective kits 300, and a grounding device 800.

[0032] The upper electrode mechanism 100 is disposed above the process chamber body 200, and the target 10 is mounted on a lower side of the upper electrode mechanism 100, and faces an interior of the process chamber body 200. The base 400 is located in the process chamber body 200 and below the target 10, and a wafer 20 to be processed is placed on the base 400. The upper electrode mechanism 100 provides the target 10 with energy for sputtering, and a material sputtered from the target 10 is deposited on the wafer 20 to form a thin film. The protective kits 300 include a protective shield 301 disposed around an inner sidewall of the process chamber body 200, and the protective shield 301 is capable of blocking the material

sputtered from the target 10 to prevent the material sputtered from the target 10 from falling to the inner sidewall and a bottom of the process chamber body 200.

[0033] In some embodiments, as shown in FIG. 1, the upper electrode mechanism 100 includes, for example, an RF power supply 101, an RF matcher 102, a DC power supply 103, a magnetron module, an upper electrode metal housing 104, and a target backing plate 106. The upper electrode metal housing 104 is provided with a downward opening, the target backing plate 106 is mounted at the opening of the upper electrode metal housing 104, and an upper electrode metal cavity is formed between the upper electrode metal housing 104 and the target backing plate 106. The target 10 may be fixed to a lower surface of the target backing plate 106 by welding or other means. The magnetron module includes, for example, a rotating shaft 109, a magnetron mounting plate 107, and a magnet 108, and the magnetron mounting plate 107 and the magnet 108 are disposed in the upper electrode metal cavity. The magnet 108 is disposed on a lower surface of the magnetron mounting plate 107, and the magnet 108 is, for example, a magnetron. A lower end of the rotating shaft 109 is disposed at a center of an upper surface of the magnetron mounting plate 107, and an upper end of the rotating shaft 109 penetrates through a top of the upper electrode metal housing 104, and extends to the outside of the upper electrode metal cavity to be connected to an external rotational drive source. A metal sleeve 105 is further provided on the upper electrode metal housing 104 and disposed around the rotating shaft 109, and the RF power supply 101 and the DC power supply 103 are both connected to the metal sleeve 105. An RF current output from the RF power supply 101 is coupled to the target 10 after sequentially flowing through the RF matcher 102, the metal sleeve 105, and the upper electrode metal housing 104. The DC power supply 103 is coupled to the target 10 through the metal sleeve 105 and the upper electrode metal housing 104. DC power and RF power are coupled to the target 10 to provide the energy for sputtering. The magnetron module may confine plasma with a magnetic field to enhance density of plasma on a surface of the target 10 and maintain stable magnetron sputtering, so that a thin film may be formed on a surface of the wafer 20 by deposition.

[0034] The process chamber body 200 is a frame that supports the entire process chamber, and may be made of a material such as stainless steel or aluminum alloy. A ceramic ring 110 is disposed between the upper electrode mechanism 100 and the process chamber, and may be sealed to the target backing plate 106 with a sealing ring. The ceramic ring 110 can isolate an internal environment of the process chamber from an external environment of the process chamber, and maintain a vacuum state inside the process chamber body 200.

[0035] The base 400 is disposed in the process chamber body 200, and a lifting mechanism for driving the base 400 to rise and fall is disposed below the base 400. The base 400 is capable of supporting the wafer 20, fixing the wafer 20 by electrostatic adsorption, and adjusting a temperature of the wafer 20 to avoid an influence of temperature fluctuation on a process. Exemplarity, as shown in FIG. 1, the base 400 includes a supporting member 401 and a cooling plate 402. The supporting member 401 is located above the cooling plate 402 for supporting and fixing the wafer 20. The supporting member 401 is generally made of a high thermal conductivity dielectric material, such as pyrolytic boron nitride, aluminum nitride, aluminum oxide, or an equivalent material. The cooling plate 402 is mainly configured to adjust the temperature of the wafer 20, and is generally made of a metal material such as stainless steel or aluminum. The wafer 20 is driven by the base 400 to rise to a processing position before a process, the target 10 is sputtered to be deposited on an upper surface of the wafer 20 to form a thin film, and the wafer 20 after the deposition may be used for production of chips or other devices. After the process is completed, the wafer 20 is driven by the base 400 to fall to a loading/unloading position, so as to facilitate removal of the processed wafer 20 and loading of another wafer 20 to be processed.

[0036] The process chamber is fed with the RF power by the upper electrode mechanism 100, and the process chamber body 200 and the lifting mechanism are both grounded. Through the plasma inside the process chamber, a part of the RF current flows to the ground through the sidewall of the process chamber body 200, and the other part of the RF current flows to the ground through the base 400 and the lifting mechanism. Due to a difference in the paths of the two parts of the RF current, the two parts of the RF current flow through different components during transmission, and potential differences exist between the components, and may cause arcing in the process chamber. The grounding device 800 is configured to electrically connect the protective shield 301 to the base 400 when the base 400 is raised to the processing position, so as to keep the protective shield 301 and the base 400 at a same potential, thereby avoiding arcing between the protective shield 301 and the base 400.

[0037] The grounding device 800 includes a first connector 810, a second connector 830, and a connecting spring 820, which are all conductors. Exemplarily, the first connector 810, the second connector 830, and the connecting spring 820 may be made of metal materials with good conductivity such as copper, aluminum, and stainless steel, and may have silver-plated surfaces to enhance conductivity. The first connector 810 is connected to the base 400, and is electrically connected to the base 400. The second connector 830 may be located below

the first connector 810 and connected to the first connector 810 through the connecting spring 820. The connecting spring 820 bears the weight of the second connector 830. The grounding device 800 is capable of rising and falling together with the base 400. When the base 400 is raised to the processing position, the second connector 830 is attached to the protective shield 301, and is electrically connected to the protective shield 301. The base 400 is electrically connected to the protective shield 301 through the grounding device 800, so that the base 400 and the protective shield 301 are at a same potential. The base 400 may be grounded through the protective shield 301 and the process chamber body 200 in sequence, which avoids arcing between the base 400 and the protective shield 301.

[0038] In the present embodiment, the process chamber body 200 is grounded, and the protective shield 301 is electrically connected to the process chamber body 200, in which case the base 400 is electrically connected to the protective shield 301 through the grounding device 800 during a process. A part of the RF current flows to the ground through the protective shield 301 and the sidewall of the process chamber body 200, and the other part of the RF current flows to the ground through the base 400 and the lifting mechanism. Due to the electrical connection between the base 400 and the protective shield 301, the base 400 and the protective shield 301 are at a same potential when the RF current flows through the base 400 and the protective shield 301, which avoids arcing between the base 400 and the protective shield 301 due to a potential difference, and improves process safety. In addition, the connecting spring 820 can extend and compress many times without being damaged, so that a service life of the grounding device 800 can be prolonged. Certainly, the protective shield 301 may be grounded by other means in practical applications, which is not limited in the embodiments of the present disclosure.

[0039] In some embodiments, the protective shield 301 is cylindrical, and has an upward folded part at a lower end thereof, and an inner peripheral surface of the folded part or a lower end surface of the protective shield 301 form a contact surface for establishing electrical connection by contact with the second connector 830.

[0040] The protective kits 300 further include a deposition ring 303 and a cover ring 302, the deposition ring 303 is disposed around the supporting member 401 of the base 400, and the cover ring 302 is disposed outside and around the deposition ring 303. At least part of the cover ring 302 covers part of the deposition ring 303. During a process, the deposition ring 303 and the cover ring 302 cooperate with each other to reduce a sputtering deposit deposited around the wafer 20, so as to avoid a destructive impact of the sputtering deposit

on an edge of the base 400 and a back of the wafer 20. The deposition ring 303 is generally made of a dielectric material resistant to plasma sputtering, such as alumina ceramic and other ceramic materials. The cover ring 302 is generally made of a material resistant to plasma sputtering. For example, the cover ring 302 is made of a metal material, such as stainless steel, titanium, and aluminum; or the cover ring 302 is made of a ceramic material, such as alumina ceramic. The cover ring 302 is generally located above the folded part of the protective shield 301, and is supported by the folded part when the base 400 is lowered from the processing position.

[0041] In the present embodiment, the grounding device 800 is connected to the base 400 through a first mounting plate 501 of a bellows assembly 500, so that the bellows assembly 500 and the protective shield 301 are also at a same potential during a process, which further reduces the risk of arcing in the process chamber.

#### First Embodiment

[0042] As shown in FIG. 2 and FIG. 4, the first connector 810 in FIG. 1 is a first connecting ring 811a in FIG. 2 and FIG. 4, and the second connector 830 in FIG. 1 is a grounding ring 831 in FIG. 2 and FIG. 4. The connecting spring 820 in FIG. 1 is a connecting spring 820a in FIG. 2 and FIG. 4. The connecting spring 820a, the first connector 810, and the second connector 830 are all ring-shaped and disposed around an axis of the base 400, for example, the connecting spring 820a, the first connector 810, and the second connector 830 are coaxially disposed. The first connecting ring 811a and the grounding ring 831 are connected to two ends of the connecting spring 820a respectively, and an upper surface of the grounding ring 831 (i.e., the second connector 830) is configured to be attached to the lower end of the protective shield 301. The lower end of the protective shield 301 is, for example, a lower end surface of a bent portion of the folded part formed by folding the protective shield 301.

[0043] Exemplarily, the connecting spring 820a and the grounding ring 831 are located below the first connecting ring 811a. An outer diameter of the first connecting ring 811a is smaller than an inner diameter of the protective shield 301, so that the first connecting ring 811a is prevented from interfering with a motion of the protective shield 301 when the first connecting ring 811a is raised and lowered. An outer diameter of the grounding ring 831 is greater than the inner diameter of the protective shield 301, and an inner diameter of the grounding ring 831 is smaller than an outer diameter of the protective shield 301 and preferably smaller than the inner diameter of the protective shield 301. The grounding ring

831 is located below the protective shield 301, which allows contact of the upper surface of the grounding ring 831 (i.e., the second connector 830) with the protective shield 301.

[0044] In some embodiments, the outer diameter of the first connecting ring 811a may be the same as that of the first mounting plate 501, an inner diameter of the first connecting ring 811a is about 0.8 times the outer diameter of the first mounting plate 501, and a thickness of the first connecting ring 811a is about 0.5 cm. The inner diameter of the grounding ring 831 is the same as that of the first connecting ring 811a, a thickness of the grounding ring 831 is about 0.5 cm, and the outer diameter of the grounding ring 831 is about 1.2 to 1.5 times that of the base 400. In this way, it is ensured that the grounding ring 831 maintains good surface contact with a lower edge of the protective shield 301 when the base 400 is raised. Certainly, the dimensions of the components of the grounding device 800 may be set as required, which is not limited herein.

[0045] As shown in FIG. 2, when the base 400 is at the loading/unloading position, the connecting spring 820a is in an extended state under the weight of the grounding ring 831, and at this time, the grounding ring 831 is spaced apart from the lower end of the protective shield 301 by a certain distance. As shown in FIG. 3, when the base 400 is raised to the processing position, a lift height of the base 400 is greater than the distance between the grounding ring 831 and the lower end of the protective shield 301 when the base 400 is at the loading/unloading position, so that it can be ensured that the upper surface of the grounding ring 831 is attached to the protective shield 301 when the base 400 is raised to the processing position, which further enables electrical connection between the base 400 and the protective shield 301. Moreover, the lift process of the base 400 needs to overcome a downward pulling force applied by the connecting spring 820a to the first connecting ring 811a. At this time, the connecting spring 820a applies an upward pulling force to the grounding ring 831 to enable the grounding ring 831 to rise together with the connecting spring 820a until the upper surface of the grounding ring 831 is attached to the protective shield 301, thereby electrically connecting the base 400 to the protective shield 301.

[0046] In some embodiments, as shown in FIG. 4, the first connecting ring 811a may be provided with a plurality of connection holes 812a that axially penetrate through the first connecting ring 811a and are distributed along a circumferential direction of the first connecting ring 811a. Moreover, a plurality of screw holes are provided at a bottom of the base 400, the number of the screw holes is the same as that of the connection holes 812a, and the screw holes are in one-to-one correspondence with the connection holes 812a. The first

connecting ring 811a is connected to the base 400 with fasteners which are screw-connected to the corresponding screw holes through the connection holes 812a.

[0047] In the present embodiment, the connecting spring 820a of the grounding device 800 is disposed around the axis of the base 400, and an inner diameter and an outer diameter of the connecting spring 820a are relatively large, so that the connecting spring 820a has relatively high rigidity and is resistant to bending, which can reduce the risk of the grounding device 800 interfering with the lifting mechanism. Moreover, since the grounding ring 831 is ring-shaped, contact area between the grounding ring 831 and the protective shield 301 can be increased, so that connection resistance between the grounding ring 831 and the protective shield 301 can be reduced.

#### Second Embodiment

[0048] The connecting spring 820b, the first connector 810, and the second connector adopted in the second embodiment are different from those adopted in the first embodiment in structure. Exemplarily, as shown in FIG. 5 and FIG. 6, the first connector 810 is ring-shaped and is disposed around an axis of the base 400. An upper end of the first connector 810 is configured to be connected to the base 400; one end of the connecting spring 820b is fixedly connected to an outer circumferential surface of the first connector 810, and the other end of the connecting spring 820b is fixedly connected to the second connector; and the second connector is, for example, block-shaped, and may be a hemispherical metal component 832, and the connecting spring 820b is configured to support the second connector (i.e., the hemispherical metal component 832) to be attached to an inner side surface of the protective shield 301. That is, the connecting spring 820b may apply an elastic force to the second connector (i.e., the hemispherical metal component 832) to attach the second connector (i.e., the hemispherical metal component 832) to the inner side surface of the protective shield 301. The inner side surface of the protective shield 301 is, for example, an inner peripheral surface of the folded part of the protective shield 301.

[0049] The first connector 810 for performing the above functions may take various forms. For example, the first connector 810 includes a first connecting ring 811b, a second connecting ring 813a, and a third connecting ring 814a, which are, for example, coaxially disposed. The first connecting ring 811b and the third connecting ring 814a are located at an upper end and a lower end of the second connecting ring 813a, respectively. The first connecting ring 811b is configured to be connected to the base 400, and a specific connection mode is as follows: the first connecting ring 811b may be provided with a plurality of

connection holes 812b that axially penetrate through the first connecting ring 811b and are distributed along a circumferential direction of the first connecting ring 811b. Moreover, a plurality of screw holes are provided at a bottom of the base 400, the number of the screw holes is the same as that of the connection holes 812b, and the screw holes are in one-to-one correspondence with the connection holes 812b. The first connecting ring 811b is connected to the base 400 with fasteners which are screw-connected to the corresponding screw holes through the connection holes 812b. The second connecting ring 813a and the third connecting ring 814a are both located below the first connecting ring 811b, and the second connecting ring 813a is cylindrical and extends along an axial direction thereof, so that the first connector 810 is cylindrical as a whole.

[0050] In some embodiments, the second connector has a convex curved surface configured to be attached to an inner side surface of the protective shield 301, which can reduce a friction force between the second connector and the inner side surface of the protective shield 301, ensure smooth rise of the base 400 to the processing position, reduce particles generated by friction between the second connector and the inner side surface of the protective shield 301, and enable the second connector to still keep good electrical contact with the inner side surface of the protective shield 301 in the presence of certain bending deformation of the connecting spring 820b. In addition, the convex curved surface can play a guiding role in a fitting process between the convex curved surface and the protective shield 301.

[0051] Exemplarily, the second connector is, for example, block-shaped, and may be a hemispherical metal component 832. The connecting spring 820b extends outwards along a radial direction of the third connecting ring 814a, for example. One end of the connecting spring 820b may be fixedly connected to an outer circumferential surface of the third connecting ring 814a by welding or other means, and the other end of the connecting spring 820b may be fixedly connected to the second connector (i.e., the hemispherical metal component 832) by welding or other means. A distance between the hemispherical metal component 832 and a center of the third connecting ring 814a is greater than an inner diameter of the protective shield 301, so that the connecting spring 820b is under compression when the base 400 is raised to the processing position, thereby applying the elastic force to the second connector (i.e., the hemispherical metal component 832) to attach the second connector (i.e., the hemispherical metal component 832) to the inner side surface of the protective shield 301.

[0052] As shown in FIG. 5, the connecting spring 820b is capable of supporting the second connector (i.e., the hemispherical metal component 832) to be attached to the inner side surface of the protective shield 301. When the base 400 is at the loading/unloading position, the connecting spring 820b is in a naturally extended state, and the hemispherical metal component 832 is located on an outer peripheral side of the third connecting ring 814a, and is spaced apart from the lower end of the protective shield 301 by a certain distance. As shown in FIG. 6, when the base 400 is raised to the processing position, a lift height of the base 400 is greater than the distance between the hemispherical metal component 832 and the lower end of the protective shield 301 when the base 400 is at the loading/unloading position. When the base 400 is at the processing position, the hemispherical metal component 832 is located on an inner side of the protective shield 301, and the connecting spring 820b is under compression to support the hemispherical metal component 832 to be attached to the protective shield 301, thereby electrically connecting the base 400 to the protective shield 301. A surface of the hemispherical metal component 832 which is in contact with the protective shield 301 is hemispherical and can play a guiding role in a fitting process between the hemispherical metal component 832 and the protective shield 301. The hemispherical metal component 832 may be made of a metal material with good electrical conductivity, such as copper, aluminum, and stainless steel. Certainly, the convex curved surface of the second connector is not limited to the hemispherical surface, and may be a surface in another shape, such as an ellipsoidal surface or an arc surface, which is not limited herein

[0053] In addition, the hemispherical metal component 832 rubs against the protective shield 301 when being raised and lowered, and particles are generated due to the friction between the hemispherical metal component 832 and the protective shield 301, and may affect yield of the wafer 20. In view of this, the protective kits are further provided with the cover ring 302 and the deposition ring 303, which are located above the grounding device 800. The cover ring 302 and the deposition ring 303 are capable of blocking the particles generated by the friction between the grounding device 800 and the protective shield 301 when the grounding device 800 is raised and lowered, thereby avoiding the influence of the particles on a process. Certainly, the protective kits may be provided with the cover ring 302 and the deposition ring 303 in other embodiments, which is not limited herein.

[0054] In some embodiments, the number of the connecting springs 820b is more than one, the connecting springs 820b are uniformly distributed along a circumferential direction of the first connector 810 (e.g., the third connecting ring 814a), the number of the second

connectors (i.e., the hemispherical metal components 832) is the same as that of the connecting springs 820b, and the second connectors (i.e., the hemispherical metal components 832) are connected to the connecting springs 820b in a one-to-one correspondence. By providing a plurality of second connectors (i.e., the hemispherical metal components 832), the number of contact points between the grounding device 800 and the protective shield 301 can be increased, and connection resistance between the grounding device 800 and the protective shield 301 can be reduced. Moreover, with the plurality of connecting springs 820b uniformly distributed along the circumferential direction of the third connecting ring 814a, a resultant force of pushing forces applied by the connecting springs 820b to the third connecting ring 814a has a relatively small component force in the radial direction of the third connecting ring 814a, which can reduce the risk of damage to a part of the grounding device 800 which is connected to the base 400 due to the pushing forces of the connecting springs 820b.

[0055] In some embodiments, the first connector 810 further includes a fixing member 815.

As shown in FIG. 5 or FIG. 6, the fixing member 815 has a first surface and a second surface opposite to each other, dimensions of the first surface and the second surface in an axial direction of the third connecting ring 814a are greater than an axial dimension of the third connecting ring 814a, the first surface is fixedly connected to the outer circumferential surface of the third connecting ring 814a, and the second surface is fixedly connected to the connecting spring 820b. By fixedly connecting the connecting spring 820b to the third connecting ring 814a with the fixing member 815 having the larger axial dimensions than that of the third connecting ring 814a, connection stability can be improved, and the risk of damage to a connected part can be reduced. In an embodiment, the fixing member 815 is plate-shaped, two plate-like surfaces of the fixing member are the first surface and the second surface, which are, for example, arc-shaped, and the first surface and the second surface are parallel with the outer circumferential surface of the third connecting ring 814a. One side surface (i.e., the first surface) of the fixing member 815 is fixedly connected to the outer circumferential surface of the third connecting ring 814a by welding or other means, and the other side surface (i.e., the second surface) of the fixing member 815 is fixedly connected to the connecting spring 820b by welding or other means. The fixing member 815 is perpendicular to an axial direction of the connecting spring 820b connected thereto, and the connecting spring 820b is connected to the outer circumferential surface of the third connecting ring 814a through the fixing member 815, which can improve the connection

stability and reduce the risk of the damage to the connected part. Certainly, the user may adopt other methods to connect the connecting spring 820b to the third connecting ring 814a as required, which is not limited herein.

[0056] In some embodiments, a limiting rod may be further disposed on a side of the fixing member 815 away from the third connecting ring 814a, the connecting spring 820b is sleeved around the limiting rod, and a length of the limiting rod is smaller than that of the connecting spring 820b when the connecting spring 820b is at the processing position. In a lift process of the base 400, the spring is bent downwards due to a friction force between the hemispherical metal component 832 and the protective shield 301, the limiting rod can limit a bending degree of the connecting spring 820b to ensure that the connecting spring 820b can drive the hemispherical metal component 832 to be attached to the inner side surface of the protective shield 301.

[0057] In the present embodiment, the first connector 810 is cylindrical, the upper end of the first connector 810 is connected to the base 400, and the connecting spring 820b is located at a lower end of the first connector 810, and extends outwards along a radial direction of the first connector 810. When the base 400 is raised to the processing position, the second connector (i.e., the hemispherical metal component 832) is attached to the inner side surface of the protective shield 301 to enable electrical connection between the base 400 and the protective shield 301. An acting force of the connecting spring 820b is mainly distributed in the radial direction of the first connector 810, and the acting force in the axial direction of the first connector 810 is smaller, so that a load of a part of the first connector 810 which is connected to the base 400 is reduced, and the risk of detachment of the first connector 810 from the base 400 is reduced.

### Third Embodiment

[0058] The connecting spring 820c adopted in the third embodiment differs from that adopted in the second embodiment in that an extension direction and an installation position of the connecting spring 820c are different. Exemplarily, in some embodiments, as shown in FIG. 7 and FIG. 8, the first connector 810 is ring-shaped and is disposed around an axis of the base 400. An upper end of the first connector 810 is configured to be connected to the base 400; an outer circumferential surface of the first connector 810 is provided with a flange 814b1; the connecting spring 820c is disposed on the flange 814b1, one end of the connecting spring 820c is connected to an upper surface of the flange 814b1, the other end of the connecting spring 820c is fixedly connected to the second connector, and the connecting

spring 820c is configured to support the second connector to be attached to the lower end of the protective shield 301. The lower end of the protective shield 301 is, for example, a lower end surface of a bent portion of the folded part formed by folding the protective shield 301.

[0059] The first connector 810 for performing the above functions may take various forms.

5 For example, the first connector 810 includes a first connecting ring 811c, a second connecting ring 813b, and a third connecting ring 814b, which are, for example, coaxially disposed, and the first connecting ring 811c and the third connecting ring 814b are located at an upper end and a lower end of the second connecting ring 813b, respectively. The first connecting ring 811b is configured to be connected to the base 400, and a specific connection  
10 mode is, for example, as follows: the first connecting ring 811c may be provided with a plurality of connection holes 812c that axially penetrate through the first connecting ring 811c and are distributed along a circumferential direction of the first connecting ring 811c. Moreover, a plurality of screw holes are provided at a bottom of the base 400, the number of the screw holes is the same as that of the connection holes 812c, the screw holes are in one-  
15 to-one correspondence with the connection holes 812c, the first connecting ring 811c is connected to the base 400 with fasteners which are screw-connected to the corresponding screw holes through the connection holes 812c. The second connecting ring 813b and the third connecting ring 814b are both located below the first connecting ring 811c, and the second connecting ring 813b is cylindrical and extends along an axial direction thereof, so  
20 that the first connector 810 is cylindrical as a whole.

[0060] An edge portion of the third connecting ring 814b protrudes relative to an outer circumferential surface of the second connecting ring 813b, and the protruding portion is the flange 814b1. In some embodiments, an outer diameter of the third connecting ring 814b is greater than an inner diameter of the protective shield 301, in which case the flange 814b1  
25 is ring-shaped. The connecting spring 820c is disposed vertically on the upper surface of the flange 814b1 in a natural state, and the second connector is, for example, a connecting metal component 833 disposed at an upper end of the connecting spring 820c. As shown in FIG. 7, when the base 400 is at the loading/unloading position, the connecting spring 820c is under compression under the weight of the second connector (i.e., the connecting metal component  
30 833), and at this time, the second connector (i.e., the connecting metal component 833) is spaced apart from the lower end of the protective shield 301 by a certain distance. As shown in FIG. 8, the base 400 is raised to the processing position, a lift height of the base 400 is greater than the distance between the second connector (i.e., the connecting metal component

833) and the lower end of the protective shield 301 when the base 400 is at the loading/unloading position. Therefore, the lift process of the base 400 may cause the second connector (i.e., the connecting metal component 833) to be attached to the lower end of the protective shield 301, and cause further compression of the connecting spring 820c. At this time, the connecting spring 820c applies an upward pushing force to the second connector (i.e., the connecting metal component 833) to cause an upper surface of the second connector (i.e., the connecting metal component 833) to be attached to the protective shield 301, thereby electrically connecting the base 400 to the protective shield 301.

[0061] In some embodiments, the second connector 830 is the connecting metal component 833. Exemplarily, a plurality of connecting metal components 833 are provided, each connecting metal component 833 is, for example, block-shaped and has an upper surface configured to be attached to the lower end of the protective shield 301, and the upper surface is flat, for example, or the upper surface is a convex curved surface as described in the second embodiment. The number of the connecting springs 820c is more than one, the connecting springs 820c are uniformly distributed along a circumferential direction of the first connector 810 (e.g., the third connecting ring 814b), the number of the second connectors (i.e., the connecting metal components 833) is the same as that of the connecting springs 820c, and the second connectors (i.e., the connecting metal components 833) are connected to the connecting springs 820c in a one-to-one correspondence. In order to ensure that the second connectors (i.e., the connecting metal components 833) can be attached to the lower end of the protective shield 301, the connecting springs 820c are distributed along an orthographic projection of the protective shield 301 on the upper surface of the third connecting ring 814b, and the second connectors 830 are fixed to the upper ends of the connecting springs 820c in a one-to-one correspondence. By providing a plurality of second connectors (i.e., the connecting metal components 833), the number of contact points between the grounding device 800 and the protective shield 301 can be increased, and connection resistance between the grounding device 800 and the protective shield 301 can be reduced. Due to the contact between the upper surfaces of the second connectors (i.e., the connecting metal components 833) and the lower end of the protective shield 301, contact area between the upper surfaces of the second connectors (i.e., the connecting metal components 833) and the lower end of the protective shield 301 can be increased, and the connection resistance can be further reduced.

[0062] In some other embodiments, the second connector 830 may be ring-shaped and disposed around the axis of the base 400. The number of the connecting springs 820c is more than one, and the connecting springs 820c are uniformly distributed along a circumferential direction of the first connector 810 (e.g., the third connecting ring 814b). In order to ensure that the second connectors (i.e., the connecting metal components 833) can be attached to the lower end of the protective shield 301, the connecting springs 820c are distributed along an orthographic projection of the protective shield 301 on the upper surface of the third connecting ring 814b, and the second connectors (i.e., the connecting metal components 833) are fixedly connected to the upper ends of the connecting springs 820c. With the plurality of connecting springs 820c uniformly distributed along the circumferential direction of the third connecting ring 814b, a uniform pushing force can be applied to the second connectors (i.e., the connecting metal components 833) to cause the second connectors (i.e., the connecting metal components 833) to fully contact the protective shield 301, thereby reducing the connection resistance.

[0063] In the present embodiment, the outer diameter of the third connecting ring 814b is greater than the inner diameter of the protective shield 301, the second connector (i.e., the connecting metal component 833) is disposed on the flange 814b1 formed by the edge portion of the third connecting ring 814b, and the connecting spring 820c supports the second connector (i.e., the connecting metal component 833) to be attached to the lower end of the protective shield 301. The structure of the grounding device 800 can meet the process requirement of a wide range of a motion of the base 400, and is beneficial to process development and debugging.

[0064] In some embodiments, the process chamber further includes a lifting shaft 600 and the bellows assembly 500. An upper end of the lifting shaft 600 is connected to a bottom of the base 400, a lower end of the lifting shaft 600 penetrates through the bottom of the process chamber body 200, and extends to the outside of the process chamber body 200, and the lifting shaft 600 is configured to drive the base 400 to rise and fall. Exemplarily, a lifting hole is provided at the bottom of the process chamber body 200, and the lower end of the lifting shaft 600 extends out of the process chamber body 200 through the lifting hole to drive the base 400 to rise and fall. The lower end of the lifting shaft 600 is connected to a lift drive source, for example. The bellows assembly 500 is disposed between the bottom of the base 400 and a bottom surface of the process chamber body 200 and around the lifting shaft 600, the lifting hole is located in a space enclosed by the bellows assembly 500, a lower

end of the bellows assembly 500 is hermetically connected to the bottom surface of the process chamber body 200, and an upper end of the bellows assembly 500 is hermetically connected to the bottom of the base 400, so that the space enclosed by the bellows assembly 500 can be isolated from an interior of the process chamber to ensure sealing performance of the process chamber body 200. The bellows assembly 500 is capable of expanding and contracting as the base 400 is raised and lowered, thereby ensuring sealing of the process chamber body 200 as the base 400 is raised and lowered.

[0065] As shown in FIG. 1, the bellows assembly 500 includes the first mounting plate 501, a second mounting plate 503, and a bellows 502. The bellows 502 is sleeved outside the lifting shaft 600, the first mounting plate 501 and the second mounting plate 503 are located at an upper end and a lower end of the bellows 502 respectively, the first mounting plate 501 is hermetically connected to the base 400, the second mounting plate 503 is disposed around the lifting shaft 600, and is hermetically connected to the bottom surface of the process chamber body 200, and the first connector 810 is fixedly connected to the first mounting plate 501. Exemplarily, the first mounting plate 501 and the second mounting plate 503 are both ring-shaped, the first mounting plate 501 may be fixed to the cooling plate 402 of the base 400 by welding, the second mounting plate 503 is disposed around the lifting shaft 600, and is hermetically connected to the bottom surface of the process chamber body 200, the bellows 502 is located between the first mounting plate 501 and the second mounting plate 503, and the lifting hole is located in a space enclosed by the bellows 502. The bellows 502 expands and contracts as the base 400 is raised and lowered, thereby ensuring the sealing of the process chamber body 200 when the base 400 is raised and lowered.

[0066] In some embodiments, an RF electrode in the base 400 is connected to a second RF matcher 700 through a wire passing through the lifting shaft 600, and the second RF matcher 700 may adjust an impedance of the base 400 to the ground, so as to adjust a bias voltage at a surface of the base 400. The base 400 is electrically connected to the protective shield 301 through the grounding device 800, so that the base 400 and the protective shield 301 are at a same potential, which can avoid arcing between the base 400 and the protective shield 301.

[0067] In some embodiments, the grounding device 800 may be connected to the first mounting plate 501 of the bellows assembly 500, so as to keep the bellows assembly 500 and the protective shield 301 at a consistent potential during a process. As shown in FIG. 1, the first connector 810 of the grounding device 800 may be fixed to a bottom of the first mounting plate 501 by screws, and an installation position of the first connector 810 is at a

lower surface of the first mounting plate 501 and is about 2 cm away from an edge of the first mounting plate 501. Certainly, the position of the first connecting ring 811 may be set as required in practical applications, which is not limited herein.

5 [0068] In the other technical solution, referring to FIG. 1, an embodiment of the present disclosure further provides a semiconductor processing device, including an upper electrode mechanism 100 and a process chamber. The process chamber is the process chamber provided in the embodiments of the present disclosure.

[0069] The semiconductor processing device is described in detail in the above embodiments, and will not be described here.

10 [0070] By adopting the process chamber provided in the embodiments of the present disclosure, the semiconductor processing device provided in the embodiment of the present disclosure avoids arcing between the base and the protective shield.

[0071] It should be understood that the above implementations are just exemplary implementations adopted to illustrate the principle of the present disclosure, and the present  
15 disclosure is not limited thereto. Various modifications and improvements can be made by those of ordinary skill in the art without departing from the spirit and essence of the present disclosure, and those modifications and improvements are also considered to fall within the scope of the present disclosure.

**What is claimed is:**

1. A process chamber of a semiconductor processing device, comprising a process chamber body, a base, a protective shield, and a grounding device; wherein

the base is movably disposed in the process chamber body, and is configured to support a wafer;

the protective shield is disposed around an inner sidewall of the process chamber body, and is configured to protect the inner sidewall of the process chamber body; and

the grounding device comprises a first connector, a second connector, and a connecting spring, the first connector is connected to the base, the second connector is connected to the first connector through the connecting spring, and the second connector is capable of being attached to the protective shield when the base is raised to a processing position, so as to electrically connect the base to the protective shield.

2. The process chamber of claim 1, wherein the connecting spring, the first connector, and the second connector are all ring-shaped and disposed around an axis of the base, the first connector and the second connector are connected to two ends of the connecting spring respectively, and an upper surface of the second connector is configured to be attached to a lower end of the protective shield.

3. The process chamber of claim 1, wherein the first connector is ring-shaped and disposed about an axis of the base, and an upper end of the first connector is configured to be connected to the base; and

one end of the connecting spring is fixedly connected to an outer circumferential surface of the first connector, the other end of the connecting spring is fixedly connected to the second connector, and the connecting spring is configured to support the second connector to be attached to an inner side surface of the protective shield.

4. The process chamber of claim 3, wherein the first connector comprises a first connecting ring, a second connecting ring, and a third connecting ring, the first connecting ring and the third connecting ring are located at an upper end and a lower end of the second connecting ring respectively, and the first connecting ring is configured to be connected to the base; and

one end of the connecting spring is fixedly connected to an outer circumferential surface of the third connecting ring.

5        5. The process chamber of claim 3, wherein the second connector has a convex curved surface, which is configured to be attached to the inner side surface of the protective shield.

10        6. The process chamber of claim 4, wherein the first connector further comprises a fixing member, which has a first surface and a second surface opposite to each other, dimensions of the first surface and the second surface in an axial direction of the third connecting ring are greater than an axial dimension of the third connecting ring, the first surface is fixedly connected to the outer circumferential surface of the third connecting ring, and the second surface is fixedly connected to the connecting spring.

15        7. The process chamber of claim 1, wherein the first connector is ring-shaped and disposed about an axis of the base, and an upper end of the first connector is configured to be connected to the base; and an outer circumferential surface of the first connector is provided with a flange; and

20        the connecting spring is disposed on the flange, one end of the connecting spring is connected to an upper surface of the flange, the other end of the connecting spring is fixedly connected to the second connector, and the connecting spring is configured to support the second connector to be attached to a lower end of the protective shield.

25        8. The process chamber of claim 7, wherein the first connector comprises a first connecting ring, a second connecting ring, and a third connecting ring, the first connecting ring and the third connecting ring are located at an upper end and a lower end of the second connecting ring respectively, and the first connecting ring is configured to be connected to the base; and

30        an edge portion of the third connecting ring protrudes relative to an outer circumferential surface of the second connecting ring, and the protruding portion is the flange.

9. The process chamber of claim 3 or 7, wherein a number of connecting springs is

more than one, the connecting springs are uniformly distributed along a circumferential direction of the first connector, a number of second connectors is the same as the number of the connecting springs, and the second connectors are connected to the connecting springs in a one-to-one correspondence.

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10. The process chamber of claim 7, wherein a number of connecting springs is more than one, the connecting springs are uniformly distributed along a circumferential direction of the first connector, the second connector is ring-shaped and disposed around the axis of the base, and the second connector is fixedly connected to the other end of each connecting spring.

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11. The process chamber of any one of claims 1 to 8 and 10, further comprising a lifting shaft and a bellows assembly, wherein

an upper end of the lifting shaft is connected to a bottom of the base, a lower end of the lifting shaft penetrates through a bottom of the process chamber body, and extends to the outside of the process chamber body, and the lifting shaft is configured to drive the base to rise and fall; and

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the bellows assembly comprises a first mounting plate, a second mounting plate, and a bellows, the bellows is sleeved outside the lifting shaft, the first mounting plate and the second mounting plate are located at an upper end and a lower end of the bellows respectively, the first mounting plate is hermetically connected to the base, the second mounting plate is disposed around the lifting shaft, and is hermetically connected to a bottom surface of the process chamber body, and the first connector is fixedly connected to the first mounting plate.

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12. The process chamber of any one of claims 1 to 8 and 10, wherein the protective shield is cylindrical and has an upward folded part at a lower end of the protective shield, and an inner peripheral surface of the folded part or a lower end surface of the protective shield form a contact surface for establishing electrical connection by contact with the second connector.

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13. A semiconductor processing device, comprising a process chamber and an upper electrode mechanism disposed above the process chamber, wherein the process

chamber is the process chamber of any one of claims 1 to 12.