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Collection assembly and semiconductor pre-cleaning chamber

Abstract

The invention provides a collection assembly and a semiconductor pre-cleaning chamber, which relate to the semiconductor processing apparatus field. The collection assembly is configured to collect particle impurities in the semiconductor pre-cleaning chamber, and includes a protection plate and a collection plate arranged at an interval in the semiconductor pre-cleaning chamber. The protection plate is annular. A plurality of first through-holes are arranged at the protection plate and configured for the process gas in the semiconductor pre-cleaning chamber to pass through. The collection plate is located on a side of an air outlet end of the first through-holes and configured to capture at least a part of the particle impurities in the semiconductor pre-cleaning chamber passing through the first through-holes.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application is a national phase entry under 35 U.S.C. § 371 of International Application No. PCT/CN2021/118658, filed on Sep. 16, 2021, which claims priority to Chinese Application No. 202010980699.8 filed on Sep. 17, 2020, the entire contents of both of which are incorporated herein by reference.

TECHNICAL FIELD

(2) The present disclosure generally relates to the semiconductor processing apparatus technology field and, more particularly, to a collection assembly and a semiconductor pre-cleaning chamber.

BACKGROUND

(3) Plasma apparatuses are widely used in a manufacturing process of semiconductor chip manufacturing, packaging, light emitting diode (LED), and flat panel displays. A discharge type of a plasma apparatus used in existing technology includes DC discharge, capacitive coupling discharge, inductive coupling discharge, and electron cyclotron resonance discharge, etc., which are widely used in physical vapor deposition (PVD), plasma etching, and chemical vapor deposition (CVD), etc.

(4) In the existing technology, after processes, such as integrated circuit (IC) manufacturing, through silicon via (TSV), and packaging, are performed on the wafer, pre-cleaning needs to be performed on the wafer. Then, metal films such as aluminum and copper are deposited by magnetron sputtering to form metal contacts or metal interconnections. The pre-cleaning process is performed in a semiconductor pre-cleaning chamber (e.g., a pre-cleaning chamber). Gases such as Ar (argon), He (helium), and H2 (hydrogen) are excited into the plasma to generate a large amount of active groups, such as electrons, ions, excited atoms, molecules, and free radicals. These active groups have various chemical reactions and physical bombardment with the surface of the wafer to remove impurities on the surface of the wafer to facilitate the subsequent PVD process to be effectively performed and significantly improve the adhesion of the deposited film. Otherwise, the impurities on the surface of the wafer will significantly increase the resistance of the circuit to increase the heat loss of the circuit to further reduce the performance of the chip.
(5) However, the semiconductor pre-cleaning chamber in the existing technology has a poor collection effect on particle impurities. The residual particle impurities are likely to cause contamination of an inner wall surface of the semiconductor pre-cleaning chamber. The contaminated semiconductor pre-cleaning chamber will cause a high risk of contaminating the pre-cleaned wafer a second time.

SUMMARY

(6) The present disclosure is intend to solve one of the technical problems in the existing technology and provides a collection assembly and a semiconductor pre-cleaning chamber to solve. Thus, the technical problem of a collection effect of particle impurities is poor, and the remaining particle impurities are easy to cause contamination on the inner wall of the semiconductor precleaning chamber to bring a high risk of contaminating the wafer again in the semiconductor pre-cleaning chamber in the existing technology.
(7) A first purpose of the present disclosure is to provide a collection assembly configured to collect particle impurities in a semiconductor pre-cleaning chamber and including a protection plate and a collection plate arranged at an interval in the semiconductor pre-cleaning chamber, wherein the protection plate is annular, and a plurality of first through-holes for a process gas of the semiconductor pre-cleaning chamber to pass are arranged at the protection plate; and the collection plate is located on a side of a gas outlet end of the first through-holes and configured to capture at least a part of the particle impurities in at least part of the semiconductor pre-cleaning chamber passing through the first through-holes.
(8) In some embodiments, the collection plate is annular and arranged opposite to the protection plate, and orthogonal projections of all the first through-holes of the protection plate on a horizontal plane are within an orthogonal projection of the collection plate on the horizontal plane.
(9) In some embodiments, a surface of the collection plate opposite to the protection plate is a plane, and the plane is parallel to the protection plate or is inclined relative to the protection plate.
(10) In some embodiments, a surface of the collection plate opposite to the protection plate has a concave structure.
(11) In some embodiments, the concave structure includes an annular concave groove arranged around a circumference of the collection plate.
(12) In some embodiments, a shape of a longitudinal cross-section of the annular groove includes a rectangle, an arc, or a triangle.
(13) In some embodiments, an outer peripheral edge of the collection plate includes an annular protrusion extending toward a direction close to the protection plate, and a gap is provided between an end of the annular protrusion close to the protection plate and the protection plate.
(14) In some embodiments, the surface of the collection plate opposite to the protection plate is a roughened surface.
(15) In some embodiments, the collection assembly further includes a distance adjustment structure configured to adjust a distance between the collection plate and the protection plate.

(16) In some embodiments, the distance adjustment structure includes at least one distance adjustment piece, the at least one distance adjustment piece is arranged between the collection plate and the protection plate and is located at an inner or outer peripheral edge of the protection plate, and the distance between the collection plate and the protection plate is adjusted by setting a number and/or thickness of the distance adjustment piece.
(17) In some embodiments, the collection plate is also provided with a connection member, the connection member being arranged at an inner or outer peripheral edge of the collection plate, and a plurality of threaded holes being correspondingly arranged at the connection member and the protection plate and distributed at intervals along a circumference of the protection plate;
(18) and the collection assembly further includes a plurality of fastening screws, the fastening screws being threadedly connected to the threaded holes in a one-to-one correspondence and configured to fixedly connect the connection member to the protection plate.
(19) In some embodiments, at least two collection plates are arranged at intervals along a direction away from the protection plate, except a collection plate of the at least two collection plates farthest to the protection plate, a plurality of second through-holes are arranged at the other collection plates, axes of the plurality of second through-holes of two neighboring collection plates do not coincide, and axes of second through-holes of the collection plate closest to the protection plate do not coincide axes of the first through-holes of the protection plate.
(20) A second purpose of the present disclosure is to provide a semiconductor pre-cleaning chamber, including a chamber, a Faraday cup arranged in the chamber, a base configured to carry a wafer, and the collection assembly of the present disclosure, wherein the protection plate of the collection assembly is sleeved on the base, and when the base is in a process position, the protection plate cooperates with the Faraday cup to divide space inside the chamber body into an upper sub-chamber and a lower sub-chamber.
(21) The present disclosure has the following beneficial effects.
(22) The collection assembly of the present disclosure includes a protection plate and a collection plate arranged at an interval in the semiconductor pre-cleaning chamber, wherein the protection plate is annular to be able to sleeve around the base in the semiconductor pre-cleaning chamber. The protection plate is provided with a plurality of first through-holes for the process gas in the semiconductor pre-cleaning chamber to pass through. Meanwhile, hole walls of the first through-holes can collect a small amount of particle impurities carried by the airflow. The collection plate is located on a side of the air outlet end of the first through-holes and configured to capture at least a part of the particle impurities passing through the first through-holes in the semiconductor pre-cleaning chamber. Since the collection plate is opposite to the air outlet direction of the first through-holes, the airflow carrying a large amount of the particle impurities will collide with the surface of the collection plate to effectively collect the particle impurities on the surface of the collection plate. Thus, the remaining particle impurities in the pre-cleaning chamber can be greatly reduced and even does not exist, which is not easy to cause the contamination on the inner wall of the semiconductor pre-cleaning chamber and reduce the risk of contaminating the wafer again. In addition, the collection assembly of the present disclosure can be dissembled and cleaned when the collection assembly needs to be cleaned and has strong maintainability.
(23) The semiconductor pre-cleaning chamber of the present disclosure has all the advantages of the above collection assembly, which are not repeated here.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) To more clearly illustrate the technical solutions of embodiments of the present disclosure or the existing technology, the accompanying drawings used in the embodiments or the existing

technology are briefly introduced below. Obviously, the accompanying drawings in the following description are merely embodiments of the present disclosure. For those skilled in the art, without creative effort, other drawings can be obtained according to the accompanying drawings.

(2) FIG. **1** illustrates a schematic structural diagram of a semiconductor pre-cleaning chamber according to some embodiments of the present disclosure.

(3) FIG. **2** illustrates a schematic structural diagram of a collection assembly of a second form according to some embodiments of the present disclosure.

(4) FIG. **3** illustrates a schematic structural diagram of a collection assembly of a third form according to some embodiments of the present disclosure.

(5) FIG. **4** illustrates a schematic structural diagram of a collection assembly of a fourth form according to some embodiments of the present disclosure.

(6) FIG. **5** illustrates a schematic structural diagram of a collection assembly of a fifth form according to some embodiments of the present disclosure.

(7) FIG. **6** illustrates a schematic structural diagram of a collection assembly of a sixth form according to some embodiments of the present disclosure.

(8) FIG. **7** illustrates a schematic cross-sectional diagram showing a collection plate of the collection assembly of the second form according to some embodiments of the present disclosure.

(9) FIG. **8** illustrates a schematic cross-sectional diagram showing a collection plate of the collection assembly of the third form according to some embodiments of the present disclosure.

(10) FIG. **9** illustrates a schematic cross-sectional diagram showing a collection plate of the collection assembly of the fourth form according to some embodiments of the present disclosure.

(11) FIG. **10** illustrates a schematic cross-sectional diagram showing a protection plate of a collection assembly of a first form according to some embodiments of the present disclosure.

(12) FIG. **11** illustrates a schematic cross-sectional diagram showing a protection plate of the collection assembly of the second form according to some embodiments of the present disclosure.

(13) FIG. **12** illustrates a schematic cross-sectional diagram showing a protection plate of the collection assembly of the third form according to some embodiments of the present disclosure.

(14) FIG. **13** illustrates a schematic cross-sectional diagram showing a protection plate of the collection assembly of the fourth form according to some embodiments of the present disclosure.

REFERENCE NUMERALS

(15) TABLE-US-00001 100 Protection plate 110 First through-hole 120 Center through-hole 210 Collection plate 211 Annular concave groove 212 Annular protrusion 213 Threaded hole 214 Fastening screw 215 Second through-hole 220 Connection member 300 Distance adjustment piece 510 Chamber body 521 First metal ring 522 Second metal ring 530 Coil 540 Coil shielding box 550 Coupling window 560 Faraday cup 570 Cover plate 580 Quartz ring 590 Base 610 Upper electrode radio 620 Upper electrode frequency power supply matching device 630 Lower electrode radio 640 Lower electrode frequency power supply matching device 700 Vacuum pump 800 Wafer

DETAILED DESCRIPTION OF THE EMBODIMENTS

(16) To make the above objects, features, and advantages of the present disclosure more comprehensible, specific embodiments of the present disclosure are described in detail below in connection with the accompanying drawings. It should be understood that the specific embodiments described here are only used to explain the present disclosure, not to limit the present disclosure.

(17) Embodiments of the present disclosure provide a semiconductor pre-cleaning chamber. As shown in FIG. **1**, the semiconductor pre-cleaning chamber includes a chamber body **510** and a Faraday cup **560** arranged in the chamber body **510**, a base **590** configured to carry a wafer **800**, and a collection assembly. The collection assembly is mounted to sleeve the base **590**. When the base **590** is at a processing position, a protection plate **100** of the collection assembly can cooperate with the Faraday cup **560** to divide space inside the chamber body **510** into an upper sub-chamber and a lower sub-chamber.

(18) In embodiments of the present disclosure, the semiconductor pre-cleaning chamber further includes a first metal ring **521**, a second metal ring **522**, a coil **530**, a coil shielding box **540**, a coupling window **550**, a cover plate **570**, a quartz ring **580**, and an upper electrode radio frequency (RF) power supply **610**, and an upper electrode matching device **620**, a lower electrode RF power supply **630**, a lower electrode matching device **640**, and a vacuum pump **700**. It should be noted that the above structure and corresponding working principle except for the collection assembly are mature existing technology, which is not improved in the present disclosure and are not repeated here.
(19) In the semiconductor pre-cleaning chamber of the present disclosure, when the process is performed, the wafer **800** can be arranged on the base **590**. The upper electrode RF power supply **610** can apply RF power to the coil **530** through the upper electrode matching device **620**. The RF power can be coupled into the upper sub-chamber through the Faraday cup **560** to excite the process gas (e.g., argon) into a plasma. The RF power of the lower electrode RF power supply **630** can be applied to the base **590** through the lower electrode matching device **640** to cause the base **590** to generate an RF self-bias to attract the plasma to physically bombard the wafer **800** or a chemical reaction can be performed simultaneously to remove the impurities on the surface of the wafer. The particle impurities generated by the process can enter the lower sub-chamber through a first through-hole **110** of the protection plate **100**. During this process, a large amount of particle impurities can be captured and collected by the collection plate **210**, while the remaining particle impurities that are not captured by the collection plate **210** can be sucked and collected by the vacuum pump **700**.
(20) The collection assembly of embodiments of the present disclosure is described in detail below.
(21) The collection assembly of embodiments of the present disclosure can be configured to collect the particle impurities in the semiconductor pre-cleaning chamber. As shown in FIG. **1**, the collection assembly includes a protection plate **100** arranged at an interval in the semiconductor pre-cleaning chamber and a collection plate **210**. The protection plate **100** can be annular. In some embodiments, a center through-hole **120** can be arranged at the protection plate **100**. The protection plate can be sleeved on the base **590** through the center through-hole **120**. A plurality of first through-holes **110** can be arranged at the protection plate **100** and configured to allow the process gas in the semiconductor pre-cleaning chamber to pass through. That is, the process gas can pass through the first through-holes **110** from the upper sub-chamber to enter the lower sub-chamber.
(22) In embodiments of the present disclosure, as shown in FIG. **1**, the first through-holes **110** are straight through-holes with a circular cross-sectional shape. However, in other embodiments of the present disclosure, the first through-holes **110** can also be in other forms. As shown in FIG. **11**, the cross-sectional shape of the first through-holes **110** can also be rectangular. As shown in FIG. **12**, the first through-holes **110** are also folded holes. As shown in FIG. **13**, the first through-holes **110** are also oblique holes.
(23) It should be noted that, regardless of the shape of the first through-holes **110**, a diameter setting of the first through-holes **110** of the protection plate **100** meets the requirement that the plasma cannot pass through. Thus, the plasma can be effectively prevented from entering the lower sub-chamber below the protection plate **100** and causing the sub-chamber to spark.
(24) In embodiments of the present disclosure, as shown in FIG. **10**, the plurality of first through-holes **110** are arranged in three circles around the center through-hole **120** of the protection plate **100**. The first through-holes **110** of each circle can be evenly distributed along a circumference of the protection plate **100**. Such an arrangement can ensure that the airflow and particle impurities in the upper sub-chamber can flow into the first through-holes **110** in a stable and sequential manner. Of course, in other embodiments of the present disclosure, no limitation can be imposed on a number of the circles of the first through-holes **110**, a number of the first through-holes **110** of each circle, and whether the first through-holes **110** are evenly distributed.
(25) The collection plate **210** can be arranged on a side of a gas outlet end of the first through-holes

110, that is, opposite to a gas outlet direction of the first through-holes **110**, and can be configured to capture the particle impurities in at least a part of the semiconductor pre-cleaning chamber passing through the first through-holes **110**. Since the collection plate **210** is opposite to the air outlet direction of the first through-holes **110**, the airflow carrying a large amount of particle impurities can collide with the surface of the collection plate **210**. Thus, the particle impurities can be effectively collected on the surface of the collection plate **210**. Thus, the remaining particle impurities in the pre-cleaning chamber can be greatly reduced and even without residue. Therefore, the inner wall of the semiconductor pre-cleaning chamber can be difficult to be contaminated to reduce the risk of contaminating the wafer the second time. In addition, when the collection assembly of the present disclosure needs to be cleaned, the collection assembly can be dissembled for cleaning, which has strong maintainability.

(26) In some optional embodiments, the collection plate **210** can be arranged in parallel to the protection plate **100**. Of course, in practical applications, the collection plate **210** and the protection plate **100** can also form an included angle.

(27) In some optional embodiments, the collection plate **210** can be annular and arranged oppositely to the protection plate **100**. Orthographic projections of all the first through-holes **110** of the protection plate **100** on a horizontal plane can be within an orthographic projection of the collection plate **210** on the horizontal plane. Thus, the gas flowing out from all the first through-holes **110** can be ensured to collide with the surface of the collection plate **210** to further improve the collection effect of the particle impurities.

(28) In embodiments of the present disclosure, as shown in FIG. **1**, the collection plate **210** and the protection plate **100** have a same outer diameter. That is, contours of two orthogonal projections of the collection plate **210** and the protection plate **100** on the horizontal plane coincide. However, in some other embodiments of the present disclosure, the contours of the orthogonal projections of the collection plate **210** and the protection plate **100** on the horizontal plane may not coincide. For example, as shown in FIG. **2**, an outer diameter of the collection plate **210** is greater than an outer diameter of the protection plate **100**. That is, the contour of the orthogonal projection of the collection plate **210** on the horizontal plane is outside the contour of the orthogonal projection of the protection plate **100**. For another example, as shown in FIG. **3**, the outer diameter of the collection plate **210** is smaller than the outer diameter of the protection plate **100**. That is, the contour of the orthogonal projection of the collection plate **210** on the horizontal plane is inside the contour of the orthogonal projection of the protection plate **100**. Regardless of the orthographic projections of the protection plate **100** and the collection plate **210** on the horizontal plane, as long as the orthogonal projections of all the first through-holes **110** of the protection plate **100** on the horizontal plane are within the orthogonal projection of the collection plate **210** on the horizontal plane to ensure the gas flowing out of all the first through-holes **110** to be able to collide with the surface of the collection plate **210**.

(29) In embodiments of the present disclosure, as shown in FIG. **1**, a surface of the collection plate **210** opposite to the protection plate **100** is a plane. The plane is parallel to the protection plate **100**. With such an arrangement, the particle impurities discharged by the first through-holes **110** can collide reliably with the surface of the collection plate **210** to facilitate the collection of the particle impurities. Of course, in practical applications, the plane can also be inclined relative to the protection plate **100**.

(30) However, in some other embodiments of the present disclosure, the surface of the collection plate **210** opposite to the protection plate **100** may not be limited to a plane and may also have a concave structure. The concave structure can be beneficial for the particle impurities to rebound and collide between the surfaces of the protection plate **100** and the collection plate **210** opposite to each other to improve a collection rate of the particle impurities. In some embodiments, as shown in FIG. **7**, the concave structure includes an annular groove **211** arranged around the circumference of the collection plate **210**. A longitudinal cross-sectional shape of the annular groove **211** can

include a rectangle, an arc, or a triangle. For example, the annular groove **211** shown in FIG. **7** has a rectangular longitudinal cross-sectional shape. The annular groove **211** shown in FIG. **8** has an arc-shaped longitudinal cross-section shape. The annular groove **211** shown in FIG. **9** has a triangular longitudinal cross-sectional shape. In addition, the longitudinal cross-sectional shape of the annular groove **211** can further be a stepped shape (not shown).

(31) In some optional embodiments, as shown in FIG. **8**, an annular protrusion **212** extending toward a direction close to the protection plate **100** is arranged at an outer peripheral edge of the collection plate **210**. A gap is provided between an end of the annular protrusion **212** close to the protection plate **100** and the protection plate **100**. With such an arrangement, it is beneficial for the particle impurities to bounce between the collection plate **210** and the protection plate **100** to further facilitate capturing and collecting the particle impurities to improve the collection rate.

(32) In some optional embodiments, the collection assembly can further include a distance adjustment structure configured to adjust the distance between the collection plate **210** and the protection plate **100**. By adjusting the distance between the collection plate **210** and the protection plate **100**, a flowing guidance between the collection plate **210** and the protection plate **100** can be adjusted, that is, the ability to allow the gas to pass between the collection plate **210** and the protection plate **100**. Thus, an air inlet volume and an air inlet speed of the semiconductor pre-cleaning chamber can be adjusted. In some embodiments, when the distance between the collection plate **210** and the protection plate **100** is smaller, the air inlet speed can be smaller, and the collection rate can be higher. On the contrary, when the distance between the collection plate **210** and the protection plate **100** is larger, the air inlet speed can be greater, and the collection rate can be lower. Based on this, when a relatively high requirement is imposed on the residue of the particle impurities of the surface of the wafer **800**, the distance between the collection plate **210** and the protection plate **100** can be appropriately reduced to slow the air inlet speed to increase the collection rate. When a relatively low requirement is imposed on the residue of the particle impurities of the surface of the wafer **800**, or a certain requirement is imposed on the air inlet speed, the distance between the collection plate **210** and the protection plate **100** can be appropriately increased to increase the air inlet speed.

(33) In some optional embodiments, the distance between the collection plate **210** and the protection plate **100** can be greater than or equal to 3 mm and less than or equal to 20 mm.

(34) In addition, adjusting the distance between the collection plate **210** and the protection plate **100** by the above distance adjustment structure can be applied to different processes. Thus, the semiconductor pre-cleaning chamber can be integrated with functions of various processing apparatuses to reduce the apparatus cost.

(35) The above distance adjustment structure can have various structures. For example, as shown in FIGS. **1** to **4**, the above distance adjustment structure includes at least a distance adjustment piece **300**. The at least a distance adjustment piece **300** can be arranged between the collection plate **210** and the protection plate **100** and located at the inner peripheral edge or the outer peripheral edge of the protection plate **100**. By setting a number and/or a thickness of the distance adjustment piece **300**, the distance between the collection plate **210** and the protection plate **100** can be adjusted. The distance adjustment piece **300** can include, for example, a washer. In some embodiments, an inner diameter of the washer can be same as a diameter of the center through-hole **120**.

(36) Surfaces of the distance adjustment member **300** and the surfaces of the collection plate **210** opposite to the protection plate **100** can be roughened surfaces. For example, the surface of the collection plate **210** opposite to the protection plate **100** can be a surface treated by sandblasting or melting spray. With such an arrangement, the surface of the collection plate **210** can be beneficial to capture and store the particle impurities to further improve the collection effect.

(37) In embodiments of the present disclosure, as shown in FIG. **1**, one collection plate **210** is provided.

(38) However, in some other embodiments of the present disclosure, as shown in FIG. **5** and FIG.

6, a number of collection plates **210** is not limited to one. At least two collection plates **210** are provided and arranged at intervals along a direction away from the protection plate **100**. In the at least two collection plates **210**, except for the collection plate **210** farthest from the protection plate **100**, the other collection plates **210** can all be provided with a plurality of second through-holes **215**. Axes of the second through-holes **215** of two adjacent collection plates **210** cannot coincide. Axes of the second through-holes **215** of the collection plate **210** closest to the protection plate **100** cannot coincide axes of the first through-holes **110** of the protection plate **100**.

(39) By arranging the plurality of collection plates **210**, the particle impurities can be filtered and collected layer by layer to further improve the collection rate of the particle impurities. Simultaneously, by causing the axes of the second through-holes **215** of the collection plate **210** closest to the protection plate **100** to not coincide with axes of the first through-hole **110** of the protection plate **100**, the particle impurities discharged from the first through-holes **110** can be effectively prevented from continuing to transfer directly from the second through-holes **215** of the collection plate **210** closest to the protection plate **100**, which can increase the probability of the collision between the particle impurities and the surface of the collection plate **210** and is beneficial to increase the collection rate of the particle impurities. By causing the axes of the second through-holes **215** of the two adjacent collection plates **210** to not coincide, the particle impurities discharged from the collection plate **210** can be effectively prevented from continuing to transfer directly from the second through-holes **215** of the next adjacent collection plate **210**. Thus, the possibility of the particle impurities colliding with the surface of the next collection plate **210** can be increased to be beneficial for the next collection plate **210** to capture the particle impurities. Therefore, the utilization rate of the next collection plate **210** can be increased. The increment of the utilization reate of the collection plates **210** can be beneficial to increase the collection rate by using all the collection plates as a whole for the particle impurities.

(40) In some other embodiments of the present disclosure, as shown in FIG. **5** and FIG. **6**, when at least two collection plates **210** are provided. The distance adjustment piece **300** is also arranged between the two adjacent collection plates **210** to adjust the distance between the two adjacent collection plates **210**.

(41) In some optional embodiments, as shown in FIG. **2** and FIG. **3**, a connection member **220** is further arranged at the collection plate **210**. The connection member **220** can be arranged at the inner peripheral edge of the collection plate **210**. In some embodiments, as shown in FIG. **2** and FIG. **3**, the connection member **220** is a ring body. An outer diameter of the ring body can be smaller than the outer diameters of the collection plate **210** and the protection plate **100**. An inner diameter of the ring body can be the same as the diameter of the central through-hole **120**. The ring body can be arranged coaxially with the central through-hole **120**. Thus, a gap can be provided between a part of the collection plate **210** outside the connection member **220** and the protection plate **100** and configured to allow airflow to flow out during the processes.

(42) Moreover, a plurality of threaded holes **213** can be correspondingly arranged at the connection member **220**, the distance adjustment member **300**, and the protection plate **100**, and can be distributed at intervals along the circumference of the protection plate **100**. As shown in FIG. **1**, the collection assembly further includes a plurality of fastening screws **214**. The fastening screws **214** can be threadedly connected to the threaded holes **213** in a one-to-one correspondence and can be configured to fixedly connect the connection member **220**, the distance adjustment member **300**, and the protection plate **100**.

(43) In some other optional embodiments, as shown in FIG. **4**, the connection member **220** is further arranged at the outer periphery of the collection plate **210**. In some embodiments, the connection member **220** can be a ring body. An outer diameter of the ring body can be equal to the outer diameter of the protection plate **100**. An inner diameter of the ring body can be larger than the diameter of the center through-hole **120**. The ring body and the center through-hole **120** can be arranged coaxially. Thus, a gap can be arranged between the part of the collection plate **210** on an

inner side of the connection member **220** and the protection plate **100** and be configured for the airflow to flow out during the processes. Then, the airflow can flow out through the center through-hole of the collection plate **210**.

(44) In some other embodiments of the present disclosure, as shown in FIG. **5** and FIG. **6**, when the number of collection plates **210** is at least two, each collection plate **210** is provided with a connection member **220**. A collection plate **210** closest to the protection plate **100** can be a first collection plate. The other collection plates **210** can be second collection plates. A connection member **220** of the first collection plate can be arranged between the first collection plate and the protection plate **100**. A connection member **220** of a second collection plate can be arranged between two neighboring second collection plates.

(45) In some embodiments, the connection members **220** on the at least two collection plates **210** can be arranged at the inner or outer peripheral edges of the collection plates **210**, or connection members **220** of some collection plates **210** can also be arranged t the inner peripheral edges of the collection plates **210**, and connection members **220** of some other collection plates **210** can be arranged at the outer peripheral edge of the collection plates **210**. For example, as shown in FIG. **5** and FIG. **6**, the connection member **220** of the first collection plate of the collection plates **210** closest to the protection plate **100** is arranged at the outer peripheral edge of the collection plate **210** and can block the airflow from passing through between the protection plate **100** and the first collection plate. Thus, the airflow can flow out through the second through-holes **215**. The connection member **220** of the second collection plate can be arranged at the inner peripheral edge of the collection plate **210**. Moreover, the threaded holes may also not be arranged at the connection member **220** of the first collection plate. The threaded holes can be arranged at a position of the first collection plate corresponding to the threaded holes **213** of the connection member **220** of the second collection plate. Thus, the first collection plate and the second collection plate can be fixedly connected through the fastening screws **314**.

(46) Finally, it should be noted that in the specification, relational terms such as “first” and “second” are only used to distinguish one entity or operation from another entity or operation, and do not necessarily require or imply any such actual relationship or order between such entities or operations. Furthermore, the term “comprising,” “including,” or any other variation thereof is intended to cover a non-exclusive inclusion. Thus, a process, method, article, or apparatus comprising a set of elements that includes a series of elements includes not only those elements, but also includes elements not expressly listed, or elements inherent in such a process, method, article, or apparatus.

(47) With the above description of the disclosed embodiments, those skilled in the art can implement or use the present disclosure. Various modifications to the embodiments are apparent to those skilled in the art. The general principle defined in the specification may be implemented in other embodiments without departing from the spirit or scope of the present disclosure. Therefore, the present disclosure is not limited to the embodiments shown in the specification but conforms to the widest scope consistent with the principles and novel features disclosed in the specification.

Claims

1. A collection assembly configured to collect particle impurities in a semiconductor pre-cleaning chamber comprising: a protection plate being annular and including a plurality of first through-holes configured for a process gas to pass through in the semiconductor pre-cleaning chamber; at least two collection plates arranged at intervals along a direction away from the protection plate in the semiconductor pre-cleaning chamber, located on a side of a gas outlet end of the first through-holes, and configured to capture at least a part of the particle impurities in the semiconductor pre-cleaning chamber passing through the first through-holes, an outer peripheral edge of a collection plate of the at least two collection plates farthest away from the protection plate including an

annular protrusion extending toward a direction close to the protection plate, an upper surface of the annular protrusion being lower than a lower surface of the protection plate, wherein: except for the collection plate farthest away from the protection plate, a plurality of second through-holes are arranged at each of at least one other collection plate, axes of the first through-holes of the protection plate gradually move away from a central axis of the protection plate from top to bottom, and axes of second through-holes of a collection plate of the at least two collection plates closest to the protection plate gradually move toward a central axis of the collection plate closest to the protection plate from top to bottom; a first connection member arranged at an inner peripheral edge of the collection plate farthest away from the protection plate and a plurality of threaded holes are correspondingly arranged at the first connection member, the at least one other collection plate than the collection plate farthest away from the protection plate, and the protection plate, the plurality of threaded holes are distributed at intervals along a circumference of the protection plate; at least one second connection member arranged at an outer peripheral edge of the at least one other collection plate than the collection plate farthest away from the protection plate, the at least one second connection member each comprising a ring body, an upper surface of a second connection member of the collection plate closest to the protection plate contacting the lower surface of the protection plate; a distance adjustment structure including at least one distance adjustment piece arranged between the collection plate closest to the protection plate and the protection plate and configured to adjust a distance between the collection plate closest to the protection plate and the protection plate, being inside a lower sub-chamber of the semiconductor pre-cleaning chamber by setting a number and/or thickness of the distance adjustment piece, including a plurality of through-holes in a one-to-one correspondence with the plurality of threaded holes of the first connection member; and a plurality of fastening screws threadedly connected through the plurality of threaded holes of the first connection member and the plurality of through-holes of the distance adjustment structure to fixedly connect the first connection member, the distance adjustment member, and the protection plate.

2. The collection assembly according to claim 1, wherein: the collection plate closest to the protection plate is annular and arranged opposite to the protection plate; and orthogonal projections of the first through-holes of the protection plate on a horizontal plane are within an orthogonal projection of the collection plate closest to the protection plate on the horizontal plane.

3. The collection assembly according to claim 2, wherein: a surface of the collection plate closest to the protection plate opposite to the protection plate is a plane; and the plane is parallel to the protection plate or is inclined relative to the protection plate.

4. The collection assembly according to claim 2, wherein a surface of the collection plate closest to the protection plate opposite to the protection plate has a concave structure.

5. The collection assembly according to claim 4, wherein the concave structure includes an annular concave groove arranged around a circumference of the collection plate closest to the protection plate.

6. The collection assembly according to claim 5, wherein a shape of a longitudinal cross section of the annular groove includes a rectangle.

7. The collection assembly according to claim 1, wherein a gap is provided between an end of the annular protrusion close to the protection plate and the protection plate.

8. The collection assembly according to claim 1, wherein a surface of the collection plate closest to the protection plate opposite to the protection plate is a roughened surface.

9. The collection assembly according to claim 1, wherein: the at least one distance adjustment piece is located at an inner peripheral edge of the protection plate.

10. The collection assembly according to claim 1, wherein: axes of the plurality of second through-holes of two neighboring collection plates do not coincide; and the axes of the second through-holes of the collection plate closest to the protection plate do not coincide with the axes of the first through-holes of the protection plate.

11. The collection assembly according to claim 1, wherein the collection plate closest to the protection plate is a first collection plate, and the distance adjustment structure is a first distance adjustment structure; the collection assembly further comprising: a second collection plate of the at least two collection plates arranged farther away from the protection plate than the first collection plate; and a second distance adjustment structure arranged between the first collection plate and the second collection plate and configured to adjust a distance between the first collection plate and the second collection plate.