United States Patent	12387912
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Tye; Jordan B. et al.

Shield ring mounting using compliant hardware

Abstract

A system for mounting the shield ring to the pedestal in a plasma chamber is disclosed. The mounting system includes compliant hardware. A fastener with a compliant component, such as an O-ring, is first secured to the pedestal. The shield ring has a top surface, a bottom surface and walls extending downward from the inner and outer diameter of the shield ring. Bores are located on the bottom surface of the shield ring. The bores of the shield ring are aligned with the fasteners and the shield ring is then pressed down onto the fasteners. As the shield ring is being pressed down, the walls of the bores force the compliant hardware to yield. When in place, the compliant hardware supplies the requisite compression force to hold the shield ring in place. The compliant hardware may be implemented in various manners.

Inventors: **Tye; Jordan B. (Arlington, MA), Pixley; James A. (Dover, NH), Fairhurst; John R. (Plaistow, NH)**

Applicant: **Applied Materials, Inc.** (Santa Clara, CA)

Family ID: **1000008749005**

Assignee: **Applied Materials, Inc. (Santa Clara, CA)**

Appl. No.: **18/218825**

Filed: **July 06, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20250014870 A1	Jan. 09, 2025

Publication Classification

Int. Cl.: **H01J37/32** (20060101); **H01J37/317** (20060101)

U.S. Cl.:

CPC **H01J37/32513** (20130101); **H01J37/3171** (20130101); **H01J37/32651** (20130101); H01J2237/3365 (20130101)

Field of Classification Search

USPC: None

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
5558717	12/1995	Zhao	118/728	H01L 21/68742
5853607	12/1997	Zhao	438/758	H01L 21/68742
6079356	12/1999	Umotoy	118/728	H01J 37/32449
6123804	12/1999	Babassi	118/728	H01L 21/68721
6219219	12/2000	Hausmann	361/234	H01L 21/6831
9508561	12/2015	Naik	N/A	H01L 21/67184
9719169	12/2016	Mohn	N/A	C23C 16/463
10163609	12/2017	Lin	N/A	H01J 37/32192
11818810	12/2022	Kashyap	N/A	H01L 21/68735
2005/0133164	12/2004	Fischer et al.	N/A	N/A
2008/0220596	12/2007	Olander	257/E21.334	H01J 27/02
2015/0132929	12/2014	Horigome	438/513	H01L 21/2225
2015/0262869	12/2014	Naik	438/643	H01L 21/32139
2016/0363240	12/2015	Wagner et al.	N/A	N/A
2018/0012763	12/2017	Ueda	N/A	H01L 21/02057
2018/0130659	12/2017	Salimian et al.	N/A	N/A
2018/0174807	12/2017	Lin	N/A	H01L 21/265
2022/0246406	12/2021	Zhang et al.	N/A	N/A
2022/0312553	12/2021	Kashyap	N/A	H01L 21/67126
2025/0014870	12/2024	Tye	N/A	H01J 37/32651
2025/0079116	12/2024	Carrell	N/A	H01J 37/3171

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC

2008-311298	12/2007	JP	N/A
434669	12/2000	TW	N/A
452916	12/2000	TW	N/A
202240649	12/2021	TW	N/A
202303801	12/2022	TW	N/A
2019/117969	12/2018	WO	N/A

OTHER PUBLICATIONS

International Search Report and Written Opinion mailed Oct. 2, 2024 in corresponding PCT application No. PCT/ US2024/033272. cited by applicant

---

Primary Examiner: Sathiraju; Srinivas

Attorney, Agent or Firm: Nields, Lemack & Frame, LLC

Background/Summary

FIELD

(1) Embodiments of the present disclosure relate to a system for securing a shield ring in a plasma doping chamber.

BACKGROUND

(2) Plasma doping systems (PLADS) are used to process semiconductor workpieces. An antenna is typically located along an exterior wall and is used to couple energy into the plasma chamber. In another embodiment, a coil antenna is located at the top of the plasma chamber and transfers RF energy through a vacuum break. A gas inlet supplies a feed gas to the plasma chamber. When energized, the antenna causes the feed gas to ionize into a plasma. The interior of the plasma chamber also includes a pedestal, or base. A platen is disposed on the pedestal, and is used to hold the workpiece in place. The platen may be biased to attract the ions from the plasma toward the workpiece. If the bias voltage is sufficiently great, the ions will be implanted into the workpiece. In other embodiments, a lower bias voltage is used to simply deposit the ions on the surface of the workpiece.

(3) Additionally, components, such as ring electrodes may also be disposed in the pedestal, and are located outside the platen. The ring electrode may be biased to maintain a uniform plasma sheathe along the surface of the workpiece. To protect the ring electrode and other components from ion strike, a shield ring may be secured on top of the ring electrode. The shield ring may be silicon or silicon carbide with specific crystal structures and electrical conductivity.

(4) Traditionally, the shield ring is placed above the ring electrode, and screws are used to hold the shield ring in place. Specifically, the shield ring is bolted to the pedestal using a plurality of through hole connections. Caps are then placed over the screws so that the screws are not impacted by the ions. Over time, the caps may loosen and become displaced. This may result in the screws being impacted by ions, causing contamination. Additionally, the cap creates crevices that can trap particles or deposition and may cause process non-uniformity.

(5) Therefore, it would be beneficial if there was a system for securing the shield ring that did not rely on screws to secure the shield ring to the base, and also did not rely on caps to protect those screws. Further, it would be advantageous if there were no exposed metal components.

SUMMARY

(6) A system for mounting the shield ring to the pedestal in a plasma chamber is disclosed. The mounting system includes compliant hardware. A fastener with a compliant component, such as an

O-ring, is first secured to the pedestal. The shield ring has a top surface, a bottom surface and walls extending downward from the inner and outer diameter of the shield ring. Bores are located on the bottom surface of the shield ring. The bores of the shield ring are aligned with the fasteners and the shield ring is then pressed down onto the fasteners. As the shield ring is being pressed down, the walls of the bores force the compliant hardware to yield. When in place, the compliant hardware supplies the requisite compression force to hold the shield ring in place. The compliant hardware may be implemented in various manners.

(7) According to one embodiment, a plasma doping system is disclosed. The plasma doping system comprises a plasma chamber; a pedestal disposed in the plasma chamber having a plurality of holes; a platen disposed on the pedestal; a shield ring surrounding the platen, wherein a bottom surface of the shield ring comprises a plurality of bores; and a plurality of fasteners, each secured to a respective one of the plurality of holes in the pedestal and each including a compliant component; wherein each of the plurality of fasteners is disposed within a respective one of the plurality of bores in the shield ring. In some embodiments, the compliant component is electrically conductive. In some embodiments, the compliant component is in contact with the shield ring. In some embodiments, the plurality of fasteners each comprises a head and a shaft, and wherein the head comprises a radial recess, and wherein the compliant component is disposed in the radial recess. In certain embodiments, the compliant component is an O-ring or a spiral wound shield gasket. In some embodiments, the plasma doping system includes a shield ring insert disposed in a respective one of the plurality of bores, wherein an outer surface of the shield ring insert is in contact with interior walls of the respective one of the plurality of bores and wherein the compliant component is in contact with an inner surface of the shield ring insert. In some embodiments, the plurality of fasteners each comprises a head and a shaft, and wherein an outer surface of the shaft is threaded and wherein the plurality of holes in the pedestal are threaded. In some embodiments, interior walls of the plurality of bores are smooth. In some embodiments, interior walls of the plurality of bores comprise an indentation that corresponds to a location of the compliant component. In some embodiments, the compliant component comprises sheet metal comprising a plurality of spokes, wherein each spoke is bent at at least one joint. In some embodiments, each bore is formed with an indentation such that a diameter of the bore at a bottom surface is smaller than a diameter of the bore at at least one other location.

(8) According to another embodiment, an assembly for use on a pedestal in a plasma doping chamber is disclosed. The assembly comprises a shield ring shaped as an annular ring, wherein a bottom surface of the shield ring comprises a plurality of bores; and a plurality of fasteners, each having a head and a shaft, wherein the shaft is adapted to be secured to the pedestal, and wherein the head is configured to hold a compliant component; wherein each of the plurality of fasteners is disposed within a respective one of the plurality of bores in the shield ring, such that each compliant component is compressed in a respective one of the plurality of bores. In some embodiments, the head comprises a radial recess and the compliant component is disposed in the radial recess. In certain embodiments, the compliant component is an O-ring or a spiral wound shield gasket. In some embodiments, the compliant component is in contact with interior walls of the respective one of the plurality of bores. In some embodiments, the assembly includes a shield ring insert disposed in a respective one of the plurality of bores, wherein an outer surface of the shield ring insert is in contact with interior walls of the respective one of the plurality of bores and wherein the compliant component is in contact with an inner surface of the shield ring insert. In some embodiments, the compliant component comprises sheet metal comprising a plurality of spokes, wherein each spoke is bent at at least one joint. In some embodiments, each bore is formed with an indentation such that a diameter of the bore at a bottom surface is smaller than a diameter of the bore at at least one other location.

Description

BRIEF DESCRIPTION OF THE FIGURES

(1) For a better understanding of the present disclosure, reference is made to the accompanying drawings, which are incorporated herein by reference and in which:

(2) FIG. **1** is a plasma chamber in accordance with one embodiment;

(3) FIG. **2**A-**2**C show a shield ring that may be used with the plasma chamber according to one embodiment;

(4) FIG. **3** shows the fastener that may be used according to one embodiment;

(5) FIGS. **4**A-**4**B show cross-sectional view of the mounting hardware using the fastener of FIG. **3** using two different shield rings;

(6) FIGS. **5**A-**5**B show a cross-sectional view and a perspective view of the mounting hardware according to another embodiment; and

(7) FIGS. **6**A-**6**B show a cross-sectional view and a perspective view of the mounting hardware according to another embodiment.

DETAILED DESCRIPTION

(8) As described above, the present disclosure discloses a system for securing a shield ring in a plasma chamber.

(9) FIG. **1** shows a PLAD (plasma doping) system **10**. The PLAD system **10** comprises a plasma chamber **30**, which is defined by a plurality of chamber walls **32**.

(10) An antenna **20** is disposed external to the plasma chamber **30**, proximate a dielectric window **25**. The dielectric window **25** may also form part of one or more of the walls that define the plasma chamber **30**. The antenna **20** is electrically connected to a RF power supply **27**, which supplies an alternating voltage to the antenna **20**. The voltage may be at a frequency of, for example, 2 MHz or more. While the dielectric window **25** and antenna **20** are shown on part of chamber walls **32** and a top wall of the plasma chamber **30**, other embodiments are also possible. For example, the antenna **20** may also be disposed on the top of the plasma chamber **30**. For example, a coil antenna may be located at the top of the plasma chamber **30** and transfer RF energy into the plasma chamber **30** through a vacuum break. The chamber walls **32** of the plasma chamber **30** may be made of a conductive material, such as graphite, silicon, silicon carbide, aluminum, or another suitable material. These chamber walls **32** may be biased at an extraction voltage, such as by extraction power supply **80**. The extraction voltage may be, for example, 1 kV, although other voltages are within the scope of the disclosure. In certain embodiments, an extraction power supply **80** may not be used and the chamber walls **32** may be electrically connected to ground.

(11) This plasma chamber **30** may be supplied with a feed gas, which is contained in a feed gas source **70**, via a feed gas inlet **71**.

(12) The PLAD system **10** includes a platen **40** disposed within the plasma chamber **30**. The platen **40** may rest on a pedestal **50** and may be in electrical communication with a bias power supply **45**. A workpiece **90** may be disposed on the top surface of the platen **40**. The workpiece **90** may be a semiconductor wafer, such as a silicon wafer, a SiC wafer or another suitable wafer. The bias power supply **45** may be used to bias the platen **40** to a bias voltage which is more negative than the voltage of the plasma. This bias voltage attracts positive ions from the plasma toward the workpiece **90**. The magnitude of the bias voltage applied by the bias power supply **45** may determine the energy at which these positive ions strike the workpiece **90**. In certain embodiments, the magnitude of the bias voltage may be used to determine the rate of processing, such as the etch rate. The magnitude of the bias voltage may also be used to determine the depth of an implantation process. In certain embodiments, the bias voltage supplied by the bias power supply **45** may be a pulsed waveform, such as a square wave. In these embodiments, the workpiece **90** may be processed when the bias voltage is negative, but not processed when the bias voltage is ground or

positive. The frequency of the square wave may vary, and may be between 0.1 kHz and 2 MHz. Although a square wave may be used, it is understood that the duty cycle of the pulsed waveform does not have to be 50%. Rather, any duty cycle may be used. In certain embodiments, the bias voltage is applied in the form of a pulsed DC waveform. This pulsed DC waveform may have any frequency, such as between 1 kHz and 1 MHz. Further, the duty cycle is not limited by this disclosure.

(13) A shield ring **60** may be disposed along the outer edge of the workpiece **90**. In certain embodiments, the workpiece **90** is round, and the shield ring **60** is constructed as an annular ring. The shield ring **60** may be constructed of a dielectric material, a ceramic material or a semiconductor material, such as for example, silicon or silicon carbide (Sic). Other materials that do not contaminate the workpiece may also be used. In some embodiments, the shield ring **60** may be a few millimeters in thickness and have a width of several centimeters. Although the shield ring **60** is much thicker than the workpiece **90**, it may be disposed on the pedestal **50** such that the top surfaces of the workpiece **90** and the shield ring **60** are aligned. The shield ring **60** includes a top surface, which may be in the shape of an annular ring. Additionally, the shield ring **60** includes walls extending downward from the inner diameter and outer diameter of the top surface.

(14) Located beneath the shield ring **60** is the mounting hardware **100**. The mounting hardware **100** includes at least one compliant component, such as an O-ring, which is used to provide the compression force to hold the shield ring **60** in place. During installation, the mounting hardware **100** is first secured to the pedestal **50**. In certain embodiments, the pedestal **50** includes a plurality of holes **52**. In some embodiments, the mounting hardware **100** includes corresponding shafts, which are pressed into the holes **52**. In certain embodiments, these holes **52** may be threaded. In these embodiments, the mounting hardware **100** includes threaded shafts which are screwed into corresponding threaded holes in the pedestal **50**. The shield ring **60** is then pressed onto the mounting hardware **100**. Since the mounting hardware **100** includes compliant components, the mounting hardware conforms to the shield ring **60**. In this way, there are no exposed fasteners.

(15) In each of these embodiments, there is a shield ring **60**. FIG. **2**A shows the shield ring **60** mounted on the pedestal in the plasma chamber **30**. FIG. **2**B is a top view of the shield ring **60**, while FIG. **2**C is a zoomed view of the bottom surface of the shield ring **60**.

(16) As shown in FIG. **2**A, the shield ring **60** is mounted on the pedestal **50** and is shaped as an annular ring, which surrounds the platen **40**. The shield ring **60** has a height, which may be, for example between 0.125 and 0.50 inches. The width of the shield ring **60**, which is the difference between the outer radius and the inner radius may be between 1 and 3 inches.

(17) As seen in FIGS. **2**B-**2**C, the shield ring **60** has a top surface **61**, which is flat with few or no openings. In certain embodiments, holes may exist on the top surface **61** to allow the placement of current sensors, such as Faraday sensors under the shield ring **60**. The shield ring **60** also has a bottom surface **62**. The bottom surface **62** of the shield ring **60** has a plurality of bores **63**. Each bore **63** is positioned so as to align with the holes **52** in the pedestal **50**. Note that while FIG. **2**C shows a slot extending from the bore **63**, in other embodiments, this slot is not present.

(18) An outer wall **64** extends from the top surface **61** to the bottom surface **62** along the outer circumference. An inner wall **65** extends from the top surface **61** to the bottom surface **62** along the inner circumference. Further, the bores **63** define interior walls **66** which interface with the mounting hardware **100**.

(19) As noted above, the mounting hardware **100** may take various forms. The mounting hardware may include a fastener **200** which is secured to the pedestal **50**.

(20) FIG. **3** shows the fastener **200** according to one embodiment. The fastener **200** may be constructed from a suitable metal, such as aluminum or stainless steel. The fastener **200** includes a head **220** having a top surface **210**, which may include a slot **211** into which a screwdriver may be placed to tighten the fastener **200** to the pedestal **50**. In some embodiments, the slot **211** may extend through the length of the fastener **200** so as to allow access to the interior of the hole **52** of the

pedestal **50**. This may be to allow air to be exhausted from the PLAD system **10**. The fastener **200** also includes a shaft **230** extending downward from the head **220**. As noted above, the interior of the shaft **230** may be hollow. Further, although not shown, in some embodiments, where the holes **52** in the pedestal **50** are threaded, the outer surface of the shaft **230** may be threaded. The head **220** of the fastener **200** includes a radial recess **225** (see FIGS. **4**A-**4**B). The radial recess **225** may be dimensioned such that its depth in the radial direction is less than its height. While FIG. **4**A shows the radial recess **225** as being rectangular in cross-section, other groove shapes are also possible. For example, the cross-section of the radial recess **225** may be semi-circular, trapezoidal or another shape.

(21) In this way, an O-ring **250** may be disposed in the radial recess **225** and extend outward beyond the outer diameter of the head **220**. The O-ring **250** may be made from an electrically conductive material, such as silicone or one or more polymers. The polymers used may include silicone, fluorosilicone, EPDM, or other fluorocarbons. These polymers have fillers such as nickel, aluminum, silver, copper, graphite, or carbon to increase their electrical conductivity. The outer diameter of the O-ring **250** is slightly larger than that of the head **220** of the fastener **200**. This allows the O-ring **250** to comply and create an interference fit. Cross sections of the O-ring **250** may range from 0.03 inches to more than 0.2 inches.

(22) In another embodiment, the compliant component may not be silicone. Rather, the O-ring **250** may be replaced with a spiral wound shield gasket. These gaskets are constructed from a thin piece of metal and are wound and formed into an annular shape. In some embodiments, the thin piece of metal is wound around a cord or a polymer ring.

(23) The term “compliant component” is used to denote the embodiments disclosed herein and any equivalents.

(24) FIGS. **4**A and **4**B show two embodiments that utilize the fastener **200** of FIG. **3**. Each is a cross sectional view of the shield ring **60** mounted on the fastener **200**.

(25) In FIG. **4**A, the interior walls **66** of the bores **63** of the shield ring **60** are smooth. During installation, the fastener **200** is pressed or screwed into a hole **52** in the pedestal **50**. The O-ring **250** is placed in the radial recess **225**. This may be performed prior to or after the fastener **200** is attached to the pedestal **50**. The shield ring **60** is then pressed onto the fastener **200**, wherein the bores **63** are aligned with the fasteners **200**. Since the O-ring **250** is compliant, it compresses to allow the shield ring **60** to be pressed into place. Thereafter, the compression force and friction due to the O-ring **250** against the interior walls **66** holds the shield ring **60** in place.

(26) The embodiment of FIG. **4**A relies on friction to retain the shield ring **60** in place. However, it is also possible to add an additional feature to more positively engage with the compliant component. FIG. **4**B shows another embodiment of the shield ring **60** that may be utilized with the fastener **200**. In this embodiment, the interior walls **66** of the bores **63** of the shield ring **60** are contoured. Specifically, there is an indentation **67** in the interior wall **66**. In other words, the diameter of the bore is smaller at the bottom surface **62** than at a location between the top surface **61** and the bottom surface **62**. Furthermore, the interior wall **66** may be designed such that the indentation **67** is aligned with the location of the O-ring **250**. In another embodiment, the interior wall **66** may be designed as a stepped wall, wherein the diameter of the bore is smaller at the bottom surface **62** than at a location above the bottom surface **62**. Thus, in these embodiments, the interior wall **66** includes an inward protrusion **68** at the bottom surface **62**. The mounting hardware is assembled in the same manner as described with respect to FIG. **4**A. However, in this embodiment, in addition to the compression force and friction due to the O-ring **250**, the shield ring **60** is also held in place due to the inward protrusion **68** on the interior wall **66** of the bore **63**.

(27) In FIGS. **4**A-**4**B, the shield ring **60** is configured to contact the O-ring **250**. In this way, electrical and thermal conductivity exists between the shield ring **60**, the fastener **200** and the pedestal **50**.

(28) However, other configurations are also possible. FIGS. **5**A-**5**B utilizes the shield ring **60**

described in FIG. **4**A, which has smooth interior walls **66**. Additionally, FIGS. **5**A-**5**B utilizes the fastener **200** described with respect to FIG. **3**. FIG. **5**A shows a cross-sectional view of the mounting hardware installed on the pedestal **50**, while FIG. **5**B shows a perspective view of the fastener **200** and the shield ring insert **300**.

(29) In this embodiment, a shield ring insert **300** is disposed in the bore **63** of the shield ring **60**. The shield ring insert **300** may be a metal component, such as aluminum or stainless steel, which is shaped as a hollow cylinder. Further, in other embodiments, the shield ring insert **300** may not be a closed cylinder. Rather, a slit **310** may extend along the height of the shield ring insert **300**. This slit **310** allows the shield ring insert **300** to be more compliant. In other embodiments, the shield ring insert **300** is a hollow cylinder. The shield ring insert **300** has an inner surface **315**, which faces the fastener **200**. The shield ring insert **300** also has an outer surface **320** which faces the interior walls **66** of the bore **63**. In some embodiments, the outer surface **320** is smooth, and friction is used to hold the shield ring insert **300** in the bore **63**. In other embodiments, there may be knurling or another raised pattern on the outer surface **320**. This raised pattern serves to increase the friction between the shield ring insert **300** and the interior walls **66** of the bore **63**.

(30) The inner surface **315** of the shield ring insert **300** may be shaped like the interior walls **66** described in FIG. **4**B. Thus, in this embodiment, the inner surface **315** is contoured. Specifically, there is an indentation in the inner surface **315** such that the diameter of the shield ring insert **300** is smaller at the bottom surface of the bore **63** than at a location between the top surface **61** and the bottom surface **62**. Furthermore, the inner surface **315** may be designed such that the indentation is aligned with the O-ring **250**. In another embodiment, the inner surface **315** may be designed as a stepped wall, wherein the diameter of the shield ring insert **300** is smaller at the bottom surface **62** of the bore than at a location above the bottom surface **62**. Thus, in these embodiments, the inner surface **315** includes an inward protrusion near the bottom surface **62** of the bore.

(31) During installation, the shield ring insert **300** is pressed into the bore **63** on the shield ring **60**. The fastener **200** is secured to the pedestal **50**. The O-ring **250** is placed in the radial recess **225**. This may be done before or after the fastener **200** is secured to the pedestal **50**. The shield ring **60** is then aligned with the fasteners **200** and pressed down. The O-ring **250** and the shield ring insert **300** are both compliant, so there may be relative movement between these components as the shield ring **60** is pressed into position.

(32) Since the shield ring insert **300** is electrically and thermally conductive, conductivity between the shield ring **60**, the fastener **200** and the pedestal **50** is maintained.

(33) FIGS. **6**A-**6**B show an embodiment that utilizes a different fastener. FIG. **6**A shows a cross-sectional view of the mounting hardware installed in the pedestal **50**, while FIG. **6**B shows a perspective view of the fastener.

(34) The fastener **600** includes a head **610** and a shaft **620**. In some embodiments, the outer surface of the shaft **620** may be threaded to secure the fastener **600** to the pedestal **50**. In other embodiments, the shaft **620** is press fit into the holes **52** of the pedestal **50**. The head **610** rests on the shaft **620** and includes a threaded hole **611** on its top surface. This threaded hole **611** may be concentric with the shaft **620**. In some embodiments, the head **610** may also include several upward protrusions **615**, which are spaced apart along the outer perimeter of the head **610**.

(35) A compliant component **630** is affixed to the head **610** using a screw **640** that passes through the threaded hole **611**. The compliant component **630** may be a metal sheet that is formed with a plurality of radially extending spokes **631**, which may be bent with at least one joint. In the embodiment shown in FIG. **6**A, the spokes **631** are bent and have three joints, such that the distal end of each spoke **631** is disposed directly beneath a portion of that spoke **631**. In some embodiments, the bend at each joint may be 60°. In FIG. **6**A, the total bending angle of the spoke **631** is 180°, although other angles of bending may be used. In embodiments where the head **610** includes the upward protrusions **615**, the spokes **631** each extend between adjacent upward protrusions **615**.

(36) While FIGS. **6**A-**6**B show the mounting hardware as having several separate parts, it is understood that in another embodiment, this the mounting hardware may be constructed as a single machined or formed part.
(37) As illustrated in FIG. **6**A, the fastener **600** may be utilized with the shield ring **60** shown in FIG. **4**B, which has an indentation **67** and/or an inward protrusion **68**. Alternatively, the fastener **600** may be utilized with the shield ring of FIG. **4**A, which has smooth interior walls **66**.
(38) During installation, the fastener **600** is secured to the pedestal **50**. The compliant component **630** may be attached to the head **610** of the fastener **600** before or after it has been secured to the pedestal **50** by inserting a screw **640** in threaded hole **611**. The shield ring **60** is then pressed onto the fasteners **600** such that each fastener **600** enters a respective bore **63** in the shield ring **60**. The spokes **631** of the compliant component **630** bend to allow the shield ring **60** to be pressed into the fastener **600**. The outward force of the spokes **631** retains the shield ring **60** in place. Because the compliant component is metal, electrical conductivity and thermal conductivity exists between the shield ring **60**, the fastener **600** and the pedestal **50**.
(39) Thus, all of these embodiments utilize a shield ring **60**, which is a solid annular ring, has no fastening openings on its top surface **61** and includes a plurality of bores **63** on its bottom surface **62**. The bores **63** may have smooth interior walls **66**, or may be interior walls **66** that include an indentation **67**. Further, all of these embodiments include a fastener which is secured to a hole **52** in the pedestal **50**. The fasteners include a compliant component attached thereto. This compliant component may be an O-ring, a spiral wound shield gasket or a component that has a plurality of bent spokes. During installation, the bores **63** are aligned with the fasteners, which were previously secured to the pedestal **50**. The shield ring **60** is then pressed down, and the compliant component serves to retain the shield ring **60** in place. In some embodiments, a shield ring insert is disposed between the compliant component and the interior walls **66** of the bore **63**.
(40) While the present disclosure describes the use of this shield ring in a PLAD system **10**, it is understood that this mounting hardware may be employed in any system that utilizes a shield ring.
(41) The embodiments described above in the present application may have many advantages. Currently, shield rings are attached to the pedestal using screws that pass through holes in the top surface of the shield ring. Caps are then placed over the screws to protect the screws. However, the caps introduce issues by creating crevices that can trap particles or deposition or cause process non-uniformity. Additionally, as the caps become worn through usage, they may become dislodged, causing workpiece handling errors. The present system eliminates the need for these exposed screws and caps. By using fasteners with a compliant component and a shield ring with bores in its bottom surface, the fasteners are completely hidden by the shield ring. This eliminates the issues associated with the prior art.
(42) The present disclosure is not to be limited in scope by the specific embodiments described herein. Indeed, other various embodiments of and modifications to the present disclosure, in addition to those described herein, will be apparent to those of ordinary skill in the art from the foregoing description and accompanying drawings. Thus, such other embodiments and modifications are intended to fall within the scope of the present disclosure. Furthermore, although the present disclosure has been described herein in the context of a particular implementation in a particular environment for a particular purpose, those of ordinary skill in the art will recognize that its usefulness is not limited thereto and that the present disclosure may be beneficially implemented in any number of environments for any number of purposes. Accordingly, the claims set forth below should be construed in view of the full breadth and spirit of the present disclosure as described herein.

Claims

1. A plasma doping system, comprising: a plasma chamber; a pedestal disposed in the plasma chamber having a plurality of holes; a platen disposed on the pedestal; a shield ring surrounding the platen, wherein a bottom surface of the shield ring comprises a plurality of bores; and a plurality of fasteners, each secured to a respective one of the plurality of holes in the pedestal and each including a compliant component; wherein each of the plurality of fasteners is disposed within a respective one of the plurality of bores in the shield ring.
2. The plasma doping system of claim 1, wherein the compliant component is electrically conductive.
3. The plasma doping system of claim 1, wherein the compliant component is in contact with the shield ring.
4. The plasma doping system of claim 1, wherein the plurality of fasteners each comprises a head and a shaft, and wherein the head comprises a radial recess, and wherein the compliant component is disposed in the radial recess.
5. The plasma doping system of claim 4, wherein the compliant component is an O-ring or a spiral wound shield gasket.
6. The plasma doping system of claim 1, further comprising a shield ring insert disposed in a respective one of the plurality of bores, wherein an outer surface of the shield ring insert is in contact with interior walls of the respective one of the plurality of bores and wherein the compliant component is in contact with an inner surface of the shield ring insert.
7. The plasma doping system of claim 1, wherein the plurality of fasteners each comprises a head and a shaft, and wherein an outer surface of the shaft is threaded and wherein the plurality of holes in the pedestal are threaded.
8. The plasma doping system of claim 1, wherein interior walls of the plurality of bores are smooth.
9. The plasma doping system of claim 1, wherein interior walls of the plurality of bores comprise an indentation that corresponds to a location of the compliant component.
10. The plasma doping wherein the compliant component comprises sheet metal comprising a plurality of spokes, wherein each spoke is bent at at least one joint.
11. The plasma doping system of claim 1, wherein each bore is formed with an indentation such that a diameter of the bore at a bottom surface is smaller than a diameter of the bore at at least one other location.
12. An assembly for use on a pedestal in a plasma doping chamber comprising: a shield ring shaped as an annular ring, wherein a bottom surface of the shield ring comprises a plurality of bores; and a plurality of fasteners, each having a head and a shaft, wherein the shaft is adapted to be secured to the pedestal, and wherein the head is configured to hold a compliant component; wherein each of the plurality of fasteners is disposed within a respective one of the plurality of bores in the shield ring, such that each compliant component is compressed in a respective one of the plurality of bores.
13. The assembly of claim 12, wherein the head comprises a radial recess and the compliant component is disposed in the radial recess.
14. The assembly of claim 13, wherein the compliant component is an O-ring or a spiral wound shield gasket.
15. The assembly of claim 12, wherein the compliant component is in contact with interior walls of the respective one of the plurality of bores.
16. The assembly of claim 12, further comprising a shield ring insert disposed in a respective one of the plurality of bores, wherein an outer surface of the shield ring insert is in contact with interior walls of the respective one of the plurality of bores and wherein the compliant component is in contact with an inner surface of the shield ring insert.
17. The assembly of claim 12, wherein the compliant component comprises sheet metal comprising a plurality of spokes, wherein each spoke is bent at at least one joint.

18. The assembly of claim 12, wherein each bore is formed with an indentation such that a diameter of the bore at a bottom surface is smaller than a diameter of the bore at at least one other location.