# DESCRIPTION

TITLE OF THE INVENTION:

PLASMA PROCESSING APPARATUS AND SUBSTRATE SUPPORT

## Field

[0001] The present disclosure relates to a plasma processing apparatus and a substrate support.

## Background

[0002] Patent Literature 1 below discloses "a wafer placing pedestal provided with a cooling plate having a refrigerant flow path on a lower surface side of a ceramic plate having a wafer placement surface on an upper surface and incorporating an electrode, the wafer placing pedestal including a horizontal space provided in parallel with the wafer placement surface at a position closer to the wafer placement surface than the refrigerant flow path inside the wafer placing pedestal, the horizontal space having an overlapping portion overlapping the refrigerant flow path along the refrigerant flow path in plan view".

## Citation List

### Patent Literature

[0003] Patent Literature 1: JP 2023-149660 A

## Summary

### Technical Problem

[0004] The present disclosure provides a technique for suppressing an influence of a shape of a joint surface of a base on a processing result of the plasma processing on a substrate.

### Solution to Problem

[0005] A plasma processing apparatus according to one aspect of the present disclosure comprises a plasma processing chamber, a base, a high frequency power supply,

an electrostatic chuck, a joint portion and a conductive layer. the base disposed in the plasma processing chamber. the high frequency power supply electrically connected to the base. The electrostatic chuck disposed at an upper portion of the base and including an attraction electrode. the joint portion that joins the base and the electrostatic chuck. the conductive layer disposed between the base and the attraction electrode. The base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed. The conductive layer has a thickness equal to or larger than a skin depth at a frequency of high frequency power output by the high frequency power supply.

## Advantageous Effects of Invention

[0006] According to the present disclosure, it is possible to suppress the influence of the shape of the joint surface of the base on the processing result of the plasma processing on the substrate.

## Brief Description of Drawings

[0007] FIG. 1 is a diagram for describing a configuration example of a capacitively coupled plasma processing apparatus according to the first embodiment.

FIG. 2 is a cross-sectional view illustrating an example of a schematic configuration of a main body according to the first embodiment.

FIG. 3 is a plan view illustrating an example of a schematic configuration of a base according to the first embodiment.

FIG. 4 is a diagram for describing an example of a flow of high frequency power and a processing result of plasma processing in a main body according to the comparative example.

FIG. 5 is a diagram for describing an example of a flow of high frequency power and a processing result of plasma processing in the main body according to the first embodiment.

FIG. 6 is a plan view illustrating another example of a schematic configuration of the base according to the first embodiment.

FIG. 7 is a plan view illustrating another example of a schematic configuration of the base according to the first embodiment.

FIG. 8 is a cross-sectional view illustrating an example of a schematic configuration of a main body according to the second embodiment.

FIG. 9 is a plan view illustrating an example of a schematic configuration of an electrostatic chuck according to the second embodiment.

FIG. 10 is a diagram for describing an example of a processing result of plasma processing of the main body according to the comparative example.

FIG. 11 is a diagram for describing an example of a processing result of plasma processing of the main body according to the second embodiment.

Description of Embodiments

[0008] Hereinafter, embodiments of a plasma processing apparatus and a substrate support will be described in detail with reference to the drawings. Note that the plasma processing apparatus and the substrate support disclosed are not limited by the following embodiments.

[0009] In the related art, a plasma processing apparatus that performs plasma processing such as plasma etching on a substrate such as a semiconductor wafer (hereinafter, referred to as a "wafer") has been known. The plasma processing apparatus includes a substrate support on which

a substrate is placed inside a vacuum chamber. The substrate support is configured by joining a conductive base and an electrostatic chuck capable of electrostatically attracting the substrate. High frequency power is supplied to the base during plasma processing.

[0010] In the plasma processing apparatus, the shape of the joint surface, of the base, to be joined to the electrostatic chuck may affect the processing result of the plasma processing on the substrate. For example, the substrate support is configured to be able to supply a heat transfer gas between the substrate support and the placed substrate. For example, the base has a heat transfer gas flow path for allowing a heat transfer gas to flow on a joint surface joined to the electrostatic chuck. The heat transfer gas flow path may generate a bias of the electric field generated by the high frequency power, and the shape of the flow path may be transferred to the etching target film of the substrate. Therefore, a technique for suppressing the influence of the shape of the joint surface of the base on the processing result of the plasma processing on the substrate is expected.

[0011] (First embodiment)

[Apparatus configuration]

An example of a plasma processing apparatus of the present disclosure will be described. In the embodiment described below, a case where the plasma processing apparatus of the present disclosure is a plasma processing system having a system configuration will be described as an example.

[0012] Hereinafter, a configuration example of the plasma processing system will be described. FIG. 1 is a diagram for describing a configuration example of a capacitively coupled plasma processing apparatus according

to the first embodiment.

[0013] The plasma processing system includes a capacitively coupled plasma processing apparatus 1 and a controller 2. The capacitively coupled plasma processing apparatus 1 includes a plasma processing chamber 10, a gas supply unit 20, a power supply 30, and an exhaust system 40. In addition, the plasma processing apparatus 1 includes a substrate support 11 and a gas introduction unit. The gas introduction unit is configured to introduce at least one processing gas into the plasma processing chamber 10. The gas introduction unit includes a shower head 13. The substrate support 11 is disposed in the plasma processing chamber 10. The shower head 13 is disposed above the substrate support 11. In an embodiment, the shower head 13 constitutes at least a portion of a ceiling of the plasma processing chamber 10. The plasma processing chamber 10 has a plasma processing space 10s defined by the shower head 13, a side wall 10a of the plasma processing chamber 10, and the substrate support 11. The plasma processing chamber 10 has at least one gas supply port for supplying at least one processing gas into the plasma processing space 10s and at least one gas discharge port for discharging the gas from the plasma processing space. The plasma processing chamber 10 is grounded. The shower head 13 and the substrate support 11 are electrically insulated from the case of the plasma processing chamber 10.

[0014] The substrate support 11 includes a main body 111 and a ring assembly 112. The main body 111 has a central region 111a for supporting a substrate W and an annular region 111b for supporting the ring assembly 112. The wafer is an example of the substrate W. The substrate W has an upper surface at which an etching target film to be

etched is formed. The annular region 111b of the main body 111 surrounds the central region 111a of the main body 111 in plan view. The substrate W is disposed on the central region 111a of the main body 111, and the ring assembly 112 is disposed on the annular region 111b of the main body 111 so as to surround the substrate W on the central region 111a of the main body 111. Therefore, the central region 111a is referred to as a substrate support surface for supporting the substrate W, and the annular region 111b is referred to as a ring support surface for supporting the ring assembly 112.

[0015] In an embodiment, the main body 111 includes the base 1110 and an electrostatic chuck 1111. The base 1110 includes a conductive member. The conductive member of the base 1110 can function as a lower electrode. The electrostatic chuck 1111 is disposed on the base 1110. The electrostatic chuck 1111 includes a ceramic member 1111a and an electrostatic electrode (also referred to as an attraction electrode, a chuck electrode, or a clamp electrode) 1111b disposed in the ceramic member 1111a. The ceramic member 1111a has the central region 111a. In an embodiment, the ceramic member 1111a also has the annular region 111b. Note that another member surrounding the electrostatic chuck 1111, such as an annular electrostatic chuck or an annular insulating member, may have the annular region 111b. In this case, the ring assembly 112 may be disposed over the annular electrostatic chuck or the annular insulating member, or may be disposed on both the electrostatic chuck 1111 and the annular insulating member. In addition, at least one RF/DC electrode coupled to a radio frequency (RF) power supply 31 and/or a direct current (DC) power supply 32 described later may be disposed in the ceramic member 1111a. In this case, at

least one RF/DC electrode functions as a lower electrode. In a case where a bias RF signal and/or a DC signal, described below, is supplied to at least one RF/DC electrode, the RF/DC electrode is referred to as a bias electrode. Note that the conductive member of the base 1110 and at least one RF/DC electrode may function as a plurality of lower electrodes. In addition, the electrostatic electrode 1111b may function as a lower electrode. Therefore, the substrate support 11 includes at least one lower electrode. In the present embodiment, the electrostatic electrode 1111b corresponds to the attraction electrode of the present disclosure.

[0016] The ring assembly 112 includes one or a plurality of annular members. In an embodiment, the one or a plurality of annular members include one or a plurality of edge rings and at least one cove ring. The edge ring is made of a conductive material or an insulating material, and the cove ring is made of an insulating material.

[0017] The substrate support 11 may include a temperature regulation module configured to regulate at least one of the electrostatic chuck 1111, the ring assembly 112, and the substrate to a target temperature. The temperature regulation module may include a heater, a heat transfer medium, a flow path 1110a, or a combination thereof. The heat transfer fluid such as brine or gas flows through the flow path 1110a. In an embodiment, the flow path 1110a is formed in the base 1110 and one or a plurality of heaters is disposed in the ceramic member 1111a of the electrostatic chuck 1111. The substrate support 11 is configured to be able to supply a heat transfer gas to a gap between the back surface of the substrate W and the central region 111a. In the substrate support 11, the main body 111 has a flow path for allowing

a heat transfer gas to flow. The configuration of the flow path formed in the main body 111 will be described later.

[0018] The shower head 13 is configured to introduce at least one processing gas from the gas supply unit 20 into the plasma processing space 10s. The shower head 13 includes at least one gas supply port 13a, at least one gas diffusion chamber 13b, and a plurality of gas introduction ports 13c. The processing gas supplied to the gas supply port 13a passes through the gas diffusion chamber 13b and is introduced into the plasma processing space 10s from the plurality of gas introduction ports 13c. In addition, the shower head 13 includes at least one upper electrode. In addition to the shower head 13, the gas introduction unit may include one or a plurality of side gas injectors (SGI) attached to one or a plurality of openings formed in the side wall 10a.

[0019] The gas supply unit 20 may include at least one gas source 21 and at least one flow control device 22. In an embodiment, the gas supply unit 20 is configured to supply at least one processing gas from a respective corresponding gas source 21 to the shower head 13 via a respective corresponding flow control device 22. Each flow control device 22 may include, for example, a mass flow controller or a pressure control type flow control device. Additionally, the gas supply unit 20 may include one or more flow modulation devices that modulate or pulse the flow rate of the at least one processing gas.

[0020] The power supply 30 includes the RF power supply 31 coupled to the plasma processing chamber 10 via at least one impedance matching circuit. The RF power supply 31 is configured to supply at least one RF signal (RF power) to the at least one lower electrode and/or the at least one upper electrode. As a result, plasma is formed from at

least one processing gas supplied to the plasma processing space 10s. Accordingly, the RF power supply 31 may function as at least a portion of a plasma generation unit configured to generate plasma from one or more processing gases in the plasma processing chamber 10. In addition, by supplying the bias RF signal to at least one lower electrode, a bias potential is generated in the substrate W, and an ion component in the formed plasma can be drawn to the substrate W.

[0021] In an embodiment, the RF power supply 31 includes a first RF generation unit 31a and a second RF generation unit 31b. The first RF generation unit 31a is configured to be coupled to the at least one lower electrode and/or the at least one upper electrode via the at least one impedance matching circuit and generate a source RF signal (source RF power) for plasma generation. In an embodiment, the source RF signal has a frequency in a range of 10 MHz to 150 MHz. In an embodiment, the first RF generation unit 31a may be configured to generate a plurality of source RF signals having different frequencies. The one or a plurality of generated source RF signals is supplied to the at least one lower electrode and/or the at least one upper electrode.

[0022] The second RF generation unit 31b is configured to be coupled to the at least one lower electrode via the at least one impedance matching circuit and generate a bias RF signal (bias RF power). The frequency of the bias RF signal may be the same as or different from the frequency of the source RF signal. In an embodiment, the bias RF signal has a frequency lower than the frequency of the source RF signal. In an embodiment, the bias RF signal has a frequency in a range of 100 kHz to 60 MHz. In an embodiment, the second RF generation unit 31b may be

configured to generate a plurality of bias RF signals having different frequencies. The one or a plurality of generated bias RF signals is supplied to the at least one lower electrode. Also, in various embodiments, at least one of the source RF signal and the bias RF signal may be pulsed. That is, one or both of the source RF signal and the bias RF signal may be a pulse-shaped rectangular wave signal.

[0023] The power supply 30 may include a DC power supply 32 coupled to the plasma processing chamber 10. The DC power supply 32 includes a first DC generation unit 32a and a second DC generation unit 32b. In an embodiment, the first DC generation unit 32a is configured to be connected to the at least one lower electrode and generate a first DC signal. The generated first bias DC signal is applied to the at least one lower electrode. The first DC generation unit 32a is connected to the electrostatic electrode 1111b, and applies a DC signal to the electrostatic electrode 1111b when the substrate W is electrostatically attracted by DC power. When the substrate W is electrostatically attracted by AC power, an alternating current (AC) signal is applied to the electrostatic electrode 1111b. In an embodiment, the second DC generation unit 32b is configured to be connected to the at least one upper electrode and generate a second DC signal. The generated second DC signal is applied to the at least one upper electrode.

[0024] In various embodiments, at least one of the first and second DC signals may be pulsed. In this case, a sequence of voltage pulses is applied to the at least one lower electrode and/or the at least one upper electrode. The voltage pulse may have a pulse waveform of a rectangle, a trapezoid, a triangle, or a combination thereof. In an embodiment, a waveform generation unit for generating a

sequence of voltage pulses from the DC signal is connected between the first DC generation unit 32a and the at least one lower electrode. Therefore, the first DC generation unit 32a and the waveform generation unit constitute a voltage pulse generation unit. In a case where the second DC generation unit 32b and the waveform generation unit constitute the voltage pulse generation unit, the voltage pulse generation unit is connected to at least one upper electrode. The voltage pulse may have a positive polarity or a negative polarity. The sequence of voltage pulses may include one or a plurality of positive-polarity voltage pulses and one or a plurality of negative-polarity voltage pulses within one period. Note that the first and second DC generation units 32a and 32b may be provided in addition to the RF power supply 31, and the first DC generation unit 32a may be provided instead of the second RF generation unit 31b.

[0025] The exhaust system 40 can be connected to a gas discharge port 10e provided, for example, at the bottom of the plasma processing chamber 10. The exhaust system 40 may include a pressure regulation valve and a vacuum pump. The pressure in the plasma processing space 10s is adjusted by the pressure regulation valve. The vacuum pump may include a turbomolecular pump, a dry pump, or a combination thereof.

[0026] The controller 2 processes computer-executable instructions that cause the plasma processing apparatus 1 to execute the various steps described in the present disclosure. The controller 2 can be configured to control respective elements of the plasma processing apparatus 1 so as to execute various steps described herein. In an embodiment, part or all of the controller 2 may be included in the plasma processing apparatus 1. The controller 2 may

include a processing unit 2a1, a storage 2a2, and a communication interface 2a3. The controller 2 is realized by, for example, a computer 2a. The processing unit 2a1 can be configured to perform various control operations by reading a program from the storage 2a2 and executing the read program. This program may be stored in the storage 2a2 in advance, or may be acquired via a medium when necessary. The acquired program is stored in the storage 2a2, and is read from the storage 2a2 and executed by the processing unit 2a1. The medium may be various storage media readable by the computer 2a, or may be a communication line connected to the communication interface 2a3. The processing unit 2a1 may be a central processing unit (CPU). The storage 2a2 may include a random access memory (RAM), a read only memory (ROM), a hard disk drive (HDD), a solid state drive (SSD), or a combination thereof. The communication interface 2a3 may communicate with the plasma processing apparatus 1 via a communication line such as a local area network (LAN). The plasma processing apparatus 1 performs plasma processing under the control of the controller 2. For example, the plasma processing apparatus 1 performs plasma etching of the etching target film formed on the substrate W under the control of the controller 2.

[0027] Next, a configuration of the main body 111 according to the first embodiment will be described. FIG. 2 is a cross-sectional view illustrating an example of a schematic configuration of the main body 111 according to the first embodiment. The main body 111 includes the base 1110 and the electrostatic chuck 1111.

[0028] The electrostatic chuck 1111 has the electrostatic electrode 1111b disposed in the ceramic member 1111a. In addition, the first DC generation unit

32a is connected to the electrostatic electrode 1111b, and a DC signal is applied when the substrate W is electrostatically attracted.

[0029] The base 1110 is made of a conductive member. For example, the base 1110 is made of aluminum, metal matrix composites (MMC), or the like. The MMC is a composite material in which a metal and a ceramic-based reinforcement are combined. The RF power supply 31 is connected to the base 1110, and high frequency power such as a source RF signal and a bias RF signal is supplied from the RF power supply 31 during plasma processing. The base 1110 functions as a lower electrode.

[0030] The electrostatic chuck 1111 and the base 1110 are joined by an adhesive layer 1112. The electrostatic chuck 1111 is disposed at an upper surface 1110b of the base 1110, and is joined to the base 1110 by the adhesive layer 1112.

[0031] The main body 111 has the central region 111a in which the substrate W is placed. The main body 111 is configured to be able to supply a heat transfer gas to a gap between the back surface of the substrate W and the central region 111a. The main body 111 has a heat transfer gas flow path for allowing a heat transfer gas to flow. For example, the base 1110 has diffusion flow paths 11101a and 11101b defined as part of the heat transfer gas flow path on the upper surface 1110b which is a joint surface to which the electrostatic chuck 1111 is joined. In the present embodiment, the diffusion flow paths 11101a and 11101b correspond to the heat transfer gas flow paths of the present disclosure.

[0032] FIG. 3 is a plan view illustrating an example of a schematic configuration of the base 1110 according to the first embodiment. FIG. 3 illustrates the upper surface

1110b of the base 1110. The base 1110 has the upper surface 1110b on which two annular diffusion flow paths 11101a and 11101b are concentrically formed.

[0033] As shown in FIG. 2, each of the diffusion flow paths 11101a and 11101b has a recess recessed in a rectangular shape on the upper surface 1110b of the base 1110, and a space of the flow path is formed by covering an upper portion of the recesses with the adhesive layer 1112. As described above, the main body 111 can easily form the diffusion flow paths 11101a and 11101b by forming the recesses on the upper surface 1110b of the base 1110 and covering the upper portion of the recesses with the adhesive layer 1112.

[0034] The base 1110 has through holes (not illustrated) reaching the diffusion flow paths 11101a and 11101b from the lower surface 1110c, and the heat transfer gas is supplied into the through holes. As the heat transfer gas, a gas having thermal conductivity, for example, He gas or the like is suitably used. The heat transfer gas supplied through the through hole (not illustrated) flows into the diffusion flow paths 11101a and 11101b and diffuses in the diffusion flow paths 11101a and 11101b.

[0035] The electrostatic chuck 1111 and the adhesive layer 1112 have a plurality of gas holes (not illustrated) reaching the diffusion flow paths 11101a and 11101b, the plurality of gas holes corresponding to the supply positions of the heat transfer gas in the central region 111a. The heat transfer gas in the diffusion flow paths 11101a and 11101b flows into each gas hole (not illustrated) and is supplied to the central region 111a.

[0036] In the plasma processing apparatus 1, the shape of the upper surface 1110b joined to the electrostatic chuck 1111 of the base 1110 may affect the processing

result of the plasma processing on the substrate W. For example, in the plasma processing apparatus 1, the bias of the electric field generated by the high frequency power may be generated by the diffusion flow paths 11101a and 11101b formed on the upper surface 1110b of the base 1110, and the shapes of the diffusion flow paths 11101a and 11101b may be transferred to the etching target film of the substrate W.

[0037] Therefore, in the plasma processing apparatus 1 according to the first embodiment, a conductive layer 1113 is disposed between the base 1110 of the main body 111 and the electrostatic electrode 1111b. The conductive layer 1113 is disposed on the upper surface of the adhesive layer 1112.

[0038] The conductive layer 1113 is formed of a conductive material. For example, the conductive layer 1113 is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$. The conductive layer 1113 is preferably made of a material having a linear expansion coefficient close to that of the base 1110. In the present embodiment, the base 1110 is formed of MMC, and the conductive layer 1113 is formed of aluminum.

[0039] The conductive layer 1113 has a thickness equal to or larger than the skin depth at the frequency of the high frequency power supplied to the base 1110. The skin depth d can be calculated from the following equation (1), for example.

[0040] $$d=\{2/(\sigma\times\omega\times\mu)\}^{1/2} \quad (1)$$

Where, $\sigma$ is an electrical conductivity of the conductive layer 1113.

$\omega$ is an angular frequency of the current, and is an

angular velocity of the high frequency power supplied to the base 1110.

$\mu$ is an absolute permeability of the conductive layer 1113.

[0041] For example, in a case where the conductive layer 1113 is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$, and in a case where the frequency of the high frequency power supplied to the base 1110 is 100 kHz to 100 MHz, the skin depth d ranges from 5 $\mu$m to 2 mm. The conductive layer 1113 is formed to have a thickness equal to or larger than the skin depth d. For example, the conductive layer 1113 is formed to have a thickness of 5 $\mu$m to 2 mm.

[0042] As described above, in the plasma processing apparatus 1 according to the first embodiment, the conductive layer 1113 is provided between the base 1110 of the main body 111 and the electrostatic electrode 1111b, so that the high frequency power uniformly propagates to the substrate W in the in-plane direction via the conductive layer. As a result, it is possible to suppress the influence of the shape of the upper surface 1110b of the base 1110 on the processing result of the plasma processing on the substrate W. For example, it is possible to suppress the transfer of the shape of the upper surface 1110b of the base 1110 to the etching target film of the substrate W.

[0043] Here, as a comparative example, an example of a flow of high frequency power and a processing result of plasma processing in the main body 111 in a case where the conductive layer 1113 is not provided will be described. FIG. 4 is a diagram for describing an example of a flow of

high frequency power and a processing result of plasma processing in the main body 111 according to the comparative example. The main body 111 according to the comparative example does not include the conductive layer 1113. In this case, in the main body 111 according to the comparative example, the high frequency power passes toward the substrate W side along the shape of the upper surface 1110b of the base 1110. FIG. 4 illustrates an enlarged view in which the vicinity of a diffusion flow path 11101b of the main body 111 is enlarged. In the enlarged view, the flow of high frequency power is indicated by an arrow. In the enlarged view, a passage surface L1 through which the high frequency power passes is illustrated. For example, in the diffusion flow path 11101b, the high frequency power passes from the bottom surface of the diffusion flow path 11101b, and the high frequency power does not uniformly propagate to the substrate W in the in-plane direction. As a result, the shape of the upper surface 1110b of the base 1110 may affect the processing result of the plasma processing on the substrate W. For example, the bias of the electric field generated by the high frequency power may be generated by the diffusion flow paths 11101a and 11101b, and the shapes of the diffusion flow paths 11101a and 11101b may be transferred to the etching target film of the substrate W. FIG. 4 illustrates an example of a processing result of plasma processing on an etching target film 120 of the substrate W. The etching target film 120 of the substrate W has annular patterns 121a and 121b corresponding to the shapes of the diffusion flow paths 11101a and 11101b.

[0044] FIG. 5 is a diagram for describing an example of a flow of high frequency power and a processing result of plasma processing in the main body 111 according to the

first embodiment. The main body 111 according to the first embodiment includes the conductive layer 1113 between the base 1110 and the electrostatic electrode 1111b. In the main body 111 according to the first embodiment, when the high frequency power passes through the conductive layer 1113, the high frequency power propagates to the conductive layer 1113, and the high frequency power passes toward the substrate W side along the shape of the conductive layer 1113. That is, the high frequency power uniformly propagates to the substrate W in the in-plane direction via the conductive layer. FIG. 5 illustrates an enlarged view in which the vicinity of the diffusion flow path 11101b of the main body 111 is enlarged. In the enlarged view, the flow of high frequency power is indicated by an arrow. In the enlarged view, a passage surface L2 through which the high frequency power passes is illustrated. In the main body 111 according to the first embodiment, for example, also in the diffusion flow path 11101b portion, the high frequency power passes from the upper surface of the conductive layer 1113. As a result, the plasma processing apparatus 1 according to the first embodiment can suppress the influence of the shape of the upper surface 1110b of the base 1110 on the processing result of the plasma processing on the substrate W. FIG. 5 illustrates an example of a processing result of plasma processing on the etching target film 120 of the substrate W. In the main body 111 according to the first embodiment, the shapes of the diffusion flow paths 11101a and 11101b are not transferred to the etching target film 120 of the substrate W. As a result, the plasma processing apparatus 1 according to the first embodiment can suppress a decrease in yield of a semiconductor device to be manufactured on the substrate W.

[0045] In the first embodiment described above, the case where the conductive layer 1113 is provided separately from the adhesive layer 1112 is described as an example. However, the present invention is not limited thereto. The adhesive layer 1112 may include a conductive material and function as the conductive layer 1113. That is, the adhesive layer 1112 may be the conductive adhesive layer 1112. Even in a case where the adhesive layer 1112 is configured as described above, the plasma processing apparatus 1 according to the first embodiment can suppress the influence of the shape of the upper surface 1110b of the base 1110 on the processing result of the plasma processing on the substrate W. For example, it is possible to suppress the transfer of the shape of the upper surface 1110b of the base 1110 to the etching target film 120 of the substrate W.

[0046] In the first embodiment, the case where the conductive layer 1113 is provided on the upper surface of the adhesive layer 1112 is described as an example. However, the present invention is not limited thereto. The conductive layer 1113 may be provided anywhere as long as the layer is provided between the base 1110 and the electrostatic electrode 1111b. FIG. 6 is a plan view illustrating another example of the schematic configuration of the base 1110 according to the first embodiment. In FIG. 6, as the adhesive layer 1112 for joining the base 1110 and the electrostatic chuck 1111, two adhesive layers 1112a and 1112b are provided, and the conductive layer 1113 is provided between the adhesive layers 1112a and 1112b. FIG. 7 is a plan view illustrating another example of the schematic configuration of the base 1110 according to the first embodiment. In FIG. 7, the electrostatic chuck 1111 is provided with the conductive layer 1113 closer to the

base 1110 than the electrostatic electrode 1111b in the ceramic member 1111a. In the plasma processing apparatus 1 according to the first embodiment, even in a case where the main body 111 is configured as illustrated in FIG. 6 or 7, it is possible to suppress the influence of the shape of the upper surface 1110b of the base 1110 on the processing result of the plasma processing on the substrate W. For example, it is possible to suppress the transfer of the shape of the upper surface 1110b of the base 1110 to the etching target film 120 of the substrate W.

[0047] In the first embodiment, the case where the two diffusion flow paths 11101a and 11101b are formed on the upper surface 1110b of the base 1110 is described as an example. However, the present invention is not limited thereto. Only one diffusion flow path may be formed, or three or more diffusion flow paths may be formed. In addition, the above-described first embodiment can be applied not only to the central region 111a for supporting the substrate W but also to the annular region 111b for supporting the ring assembly 112.

[0048] In the first embodiment, the case where the two annular diffusion flow paths 11101a and 11101b are concentrically formed on the upper surface 1110b of the base 1110 is described as an example. However, the present invention is not limited thereto. The diffusion flow path may form a path in any shape.

[0049] The first embodiment is described above. As described above, the plasma processing apparatus 1 according to the first embodiment includes the plasma processing chamber 10, the base 1110, the RF power supply 31 (high frequency power supply), the electrostatic chuck 1111, the adhesive layer 1112 (joint portion), and the conductive layer 1113. The base 1110 is disposed in the

plasma processing chamber 10. The RF power supply 31 is electrically connected to the base 1110. The electrostatic chuck 1111 is disposed at the upper portion of the base 1110 and includes the electrostatic electrode 1111b (attraction electrode). The adhesive layer 1112 joins the base 1110 and the electrostatic chuck 1111. The conductive layer 1113 is disposed between the base 1110 and the electrostatic electrode 1111b. The base 1110 has the upper surface 1110b on which the diffusion flow paths 11101a and 11101b (heat transfer gas flow paths) defined by the base 1110 and the adhesive layer 1112 are formed. The conductive layer 1113 has a thickness equal to or larger than the skin depth at the frequency of the high frequency power output from the RF power supply 31. As a result, the plasma processing apparatus 1 can suppress the influence of the shape of the upper surface 1110b, of the base 1110, which is the joint surface to which the electrostatic chuck 1111 is joined, on the processing result of the plasma processing on the substrate W.

[0050] In addition, the adhesive layer 1112 may include a conductive material and function as the conductive layer 1113. As a result, the plasma processing apparatus 1 can suppress the influence on the processing result of the plasma processing on the substrate W while joining the base 1110 and the electrostatic chuck 1111 by the adhesive layer 1112.

[0051] The conductive layer 1113 may be disposed in the electrostatic chuck 1111. As a result, the plasma processing apparatus 1 can suppress the influence on the processing result of the plasma processing on the substrate W.

[0052] Further, the adhesive layer 1112 may include an adhesive layer 1112b (first joining layer) and an adhesive

layer 1112a (second joining layer) disposed below the first joining layer. The conductive layer 1113 is disposed between the adhesive layer 1112b and the adhesive layer 1112a. As a result, the plasma processing apparatus 1 can suppress the influence on the processing result of the plasma processing on the substrate W.

[0053] In addition, the conductive layer 1113 is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$. The thickness of the conductive layer 1113 is 5 μm to 2 mm. The frequency of the high frequency power ranges from 100 kHz to 100 MHz. As a result, the plasma processing apparatus 1 can suppress the influence on the processing result of the plasma processing on the substrate W.

[0054] The diffusion flow paths 11101a and 11101b are defined by a recess formed in the upper surface 1110b of the base 1110 and the adhesive layer 1112 covering the recess. As a result, the plasma processing apparatus 1 can easily have the diffusion flow paths 11101a and 11101b on the upper surface 1110b of the base 1110.

[0055] The base 1110 may be formed of the MMC. The conductive layer 1113 may be formed of aluminum. In this case, since the linear expansion coefficients of the MMC and the electrostatic chuck 1111 are close to each other, the plasma processing apparatus 1 can suppress occurrence of deviation between and cracking of the base 1110 and the conductive layer 1113 due to temperature change.

[0056] (Second embodiment)

Next, the second embodiment will be described. Since the configuration of the plasma processing system according to the second embodiment is similar to the configuration of the plasma processing system according to the first embodiment illustrated in FIG. 1, the description thereof

will be omitted.

[0057] A configuration of the main body 111 according to the second embodiment will be described. FIG. 8 is a cross-sectional view illustrating an example of a schematic configuration of the main body 111 according to the second embodiment. Since the main body 111 according to the second embodiment has partially the same configuration as the main body 111 according to the first embodiment illustrated in FIG. 8, the same portions are denoted by the same reference numerals, description thereof is omitted, and different portions will be mainly described.

[0058] The main body 111 according to the second embodiment is configured to be able to supply a heat transfer gas to a gap between the back surface of the substrate W and the central region 111a. The main body 111 has a flow path for allowing a heat transfer gas to flow. For example, the base 1110 has the diffusion flow paths 11101a and 11101b as part of the heat transfer gas flow path on an upper surface 1110b which is a joint surface to which the electrostatic chuck 1111 is joined.

[0059] The main body 111 according to the second embodiment has dots (not illustrated) for supporting the substrate W in the central region 111a. The main body 111 according to the second embodiment has annular intermediate seal bands 130a and 130b in the central region 111a. In the main body 111 according to the second embodiment, an annular outer peripheral seal band 131 is provided in the central region 111a along the outer peripheral side of the substrate W. The intermediate seal bands 130a and 130b, the outer peripheral seal band 131, and the dots (not illustrated) are formed at the same height. Note that the intermediate seal band is a seal band other than the outer peripheral seal band 131 disposed in the central region

111a.

[0060] FIG. 9 is a plan view illustrating an example of a schematic configuration of an electrostatic chuck 1111 according to the second embodiment. FIG. 9 illustrates the central region 111a of the electrostatic chuck 1111. The electrostatic chuck 1111 has the central region 111a in which two intermediate seal bands 130a and 130b and the outer peripheral seal band 131 are concentrically formed.

[0061] As illustrated in FIG. 8, the main body 111 according to the second embodiment supports the substrate W with the intermediate seal bands 130a and 130b, the outer peripheral seal band 131, and dots (not illustrated) provided in the central region 111a. The spaces 132a to 132c are formed between the substrate W and the central region 111a. In the spaces 132a to 132c, the heat transfer gas supplied to the central region 111a is accumulated. The intermediate seal band 130a partitions the space 132a and the space 132b, and suppresses the flow of the heat transfer gas in the space 132a into the space 132b. The intermediate seal band 130b partitions the space 132b and the space 132c, and suppresses the flow of the heat transfer gas in the space 132b into the space 132c. The outer peripheral seal band 131 defines the space 132c and the space outside the outer periphery of the substrate W, and suppresses the flow of the heat transfer gas in the space 132c to the outside of the outer periphery of the substrate W.

[0062] In the plasma processing apparatus 1, thermal resistance to the substrate W is different between contact portions such as the intermediate seal bands 130a and 130b, the outer peripheral seal band 131, and dots (not illustrated) and the spaces 132a to 132c into which the heat transfer gas is supplied. For example, the contact

portion has a thermal resistance lower than that at the spaces 132a to 132c. For this reason, a difference in temperature occurs in the plane of the substrate W, and the processing result of the plasma processing on the substrate W may be affected. Specifically, the intermediate seal bands 130a and 130b are in contact with the substrate W at the central portion of the substrate W, and the contact area is wide. Therefore, in the plasma processing apparatus 1, the temperature of the contact portion with the intermediate seal bands 130a and 130b in the plane of the substrate W decreases, and the shapes of the intermediate seal bands 130a and 130b may be transferred to the etching target film of the substrate W.

[0063] Therefore, the plasma processing apparatus 1 according to the second embodiment has the diffusion flow paths 11101a and 11101b disposed in accordance with the arrangement of the intermediate seal bands 130a and 130b. For example, the main body 111 according to the second embodiment has the diffusion flow paths 11101a and 11101b at positions below the intermediate seal bands 130a and 130b at the upper surface 1110b of the base 1110. For example, the main body 111 has a diffusion flow path 11101a at a position immediately below the intermediate seal band 130a at the upper surface 1110b of the base 1110, and has a diffusion flow path 11101b at a position immediately below the intermediate seal band 130b at the upper surface 1110b of the base 1110. The thermal resistance of the intermediate seal bands 130a and 130b in the central region 111a of the main body 111 varies in the widths and depths of the diffusion flow paths 11101a and 11101b. The diffusion flow path 11101a is formed to have a width and a depth so that the thermal resistance of the intermediate seal band 130a in the central region 111a is equal to the

thermal resistance at the spaces 132a to 132c in the central region 111a. The diffusion flow path 11101b is formed to have a width and a depth so that the thermal resistance of the intermediate seal band 130b in the central region 111a is equal to the thermal resistance at the spaces 132a to 132c in the central region 111a.

[0064] As a result, the plasma processing apparatus 1 according to the second embodiment can suppress the occurrence of a difference in temperature in the plane of the substrate W, so that it is possible to suppress the influence on the processing result of the plasma processing on the substrate W.

[0065] Here, a comparative example will be described. FIG. 10 is a diagram for describing an example of a processing result of the plasma processing of the main body 111 according to the comparative example. The main body 111 according to the comparative example has the diffusion flow paths 11101a and 11101b below a flow path 1110a through which a heat transfer fluid flows in the base 1110. In this case, in the plasma processing apparatus 1, the thermal resistance to the substrate W is different between the contact portions such as the intermediate seal bands 130a and 130b and the spaces 132a to 132c to which the heat transfer gas is supplied. In the main body 111 according to the comparative example, the thermal resistances of the intermediate seal bands 130a and 130b in the central region 111a are lower than the thermal resistances at the spaces 132a to 132c. FIG. 10 illustrates an enlarged view in which the vicinity of the intermediate seal band 130b of the main body 111 is enlarged. In the enlarged view, the thermal resistance of the intermediate seal band 130b in the central region 111a of the main body 111 is represented as thermal resistance $R_{SB}$, and the thermal resistance at

the spaces 132b and 132c in the central region 111a of the main body 111 is represented as thermal resistance $R_{He}$. In the main body 111 according to the comparative example, since the intermediate seal band 130b is in contact with the substrate W, thermal resistance $R_{SB}$<thermal resistance $R_{He}$. As a result, a difference in temperature occurs in the plane of the substrate W, and the processing result of the plasma processing on the substrate W may be affected. For example, in the plasma processing apparatus 1 according to the comparative example, the temperature of the contact portion with the intermediate seal bands 130a and 130b in the plane of the substrate W decreases, and the shapes of the intermediate seal bands 130a and 130b may be transferred to the etching target film 120 of the substrate W. FIG. 10 illustrates an example of a processing result of plasma processing on the etching target film 120 of the substrate W. The etching target film 120 of the substrate W has rings 122a and 122b corresponding to the shapes of the intermediate seal bands 130a and 130b.

[0066] FIG. 11 is a diagram for describing an example of a processing result of the plasma processing of the main body 111 according to the second embodiment. The main body 111 according to the first embodiment has the diffusion flow paths 11101a and 11101b at positions below the intermediate seal bands 130a and 130b on the upper surface 1110b of the base 1110. The diffusion flow path 11101a is formed to have a width and a depth so that the thermal resistance of the intermediate seal band 130a is equal to the thermal resistance at the spaces 132a to 132c. The diffusion flow path 11101b is formed to have a width and a depth so that the thermal resistance of the intermediate seal band 130b is equal to the thermal resistance at the spaces 132a to 132c. FIG. 11 illustrates an enlarged view

in which the vicinity of the intermediate seal band 130b of the main body 111 is enlarged. In the enlarged view, the thermal resistance $R_{SB}$ of the intermediate seal band 130b in the central region 111a of the main body 111 and the thermal resistances $R_{He}$ at the spaces 132b and 132c in the central region 111a of the main body 111 are illustrated. In the main body 111 according to the second embodiment, thermal resistance $R_{SB} \approx$ thermal resistance $R_{He}$. As a result, the main body 111 according to the second embodiment can suppress the occurrence of a difference in temperature in the plane of the substrate W, so that it is possible to suppress the influence on the processing result of the plasma processing on the substrate W. As a result, the plasma processing apparatus 1 according to the second embodiment can suppress a decrease in yield of a semiconductor device to be manufactured on the substrate W.

[0067] In the second embodiment described above, the case where the diffusion flow paths 11101a and 11101b are formed on the upper surface 1110b of the base 1110 is described as an example. However, the present invention is not limited thereto. The diffusion flow paths 11101a and 11101b may be formed above the flow path 1110a through which the heat transfer fluid flows in the base 1110. In addition, the above-described second embodiment can be applied not only to the central region 111a for supporting the substrate W but also to the annular region 111b for supporting the ring assembly 112.

[0068] In the main body 111 according to the second embodiment, as in the first embodiment, the conductive layer 1113 may be disposed between the base 1110 of the main body 111 and the electrostatic electrode 1111b. In addition, the adhesive layer 1112 may include a conductive material and function as the conductive layer 1113.

[0069] The second embodiment is described above. As described above, the plasma processing apparatus 1 according to the second embodiment includes the plasma processing chamber 10, the base 1110, the RF power supply 31 (high frequency power supply), the electrostatic chuck 1111, and the adhesive layer 1112 (joint portion). The base 1110 is disposed in the plasma processing chamber 10. The RF power supply 31 is electrically connected to the base 1110. The electrostatic chuck 1111 is disposed at the upper portion of the base 1110 and includes the electrostatic electrode 1111b (attraction electrode). The adhesive layer 1112 (joint portion) joins the base 1110 and the electrostatic chuck 1111. The annular intermediate seal bands 130a and 130b are formed in the central region 111a (upper surface) of the electrostatic chuck 1111. The diffusion flow paths 11101a and 11101b (heat transfer gas flow paths) defined by the base 1110 and the adhesive layer 1112 are formed below the intermediate seal bands 130a and 130b in the central region 111a of the base 1110. As a result, the plasma processing apparatus 1 can suppress the occurrence of a difference in temperature in the plane of the substrate W, so that it is possible to suppress the influence on the processing result of the plasma processing on the substrate W.

[0070] In addition, the base 1110 has the diffusion flow paths 11101a and 11101b at positions immediately below the intermediate seal bands 130a and 130b. In addition, the electrostatic chuck 1111 supports the substrate by the intermediate seal bands 130a and 130b, and has the upper surface at which the heat transfer gas is supplied to the spaces 132a to 132c formed by the intermediate seal bands 130a and 130b and the substrate W. The diffusion flow paths 11101a and 11101b are formed to have a width and a

depth so that the thermal resistance of the intermediate seal bands 130a and 130b is equal to the thermal resistance at the spaces 132a to 132c. As a result, the plasma processing apparatus 1 can suppress the occurrence of a difference in temperature in the plane of the substrate W, so that it is possible to suppress the influence on the processing result of the plasma processing on the substrate W.

[0071] It should be understood that the embodiments disclosed herein are illustrative in all respects and are not restrictive. Indeed, the embodiments described above may be embodied in various forms. The above embodiments may be omitted, replaced, or modified in various forms without departing from the scope and spirit of the appended claims.

[0072] In the above-described embodiment, a case where capacitively coupled plasma (CCP) is used as an example of the plasma source is described as an example. However, the disclosed technology is not limited thereto. As the plasma source, for example, inductively coupled plasma (ICP), microwave excited surface wave plasma (SWP), electron cyclotron resonance plasma (ECP), helicon wave excited plasma (HWP), or the like may be used.

[0073] In the above embodiments, the case where the plasma processing such as plasma etching is performed as the plasma processing on the substrate W is described as an example, but the present invention is not limited thereto. The plasma processing may be any treatment using plasma. For example, the plasma processing may be a film forming process, a modification process, or a heat treatment process such as ashing.

[0074] In addition, regarding the above embodiments, the following Supplementary Notes are further disclosed.

[0075] (Supplementary Note 1)

A plasma processing apparatus including

a plasma processing chamber,

a base disposed in the plasma processing chamber,

a high frequency power supply electrically connected to the base,

an electrostatic chuck disposed at an upper portion of the base and including an attraction electrode,

a joint portion that joins the base and the electrostatic chuck, and

a conductive layer disposed between the base and the attraction electrode,

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed, and

wherein the conductive layer has a thickness equal to or larger than a skin depth at a frequency of high frequency power output by the high frequency power supply.

[0076] (Supplementary Note 2)

The plasma processing apparatus according to Supplementary Note 1,

wherein the joint portion includes a conductive material and functions as the conductive layer.

[0077] (Supplementary Note 3)

The plasma processing apparatus according to Supplementary Note 1,

wherein the conductive layer is disposed in the electrostatic chuck.

[0078] (Supplementary Note 4)

The plasma processing apparatus according to Supplementary Note 1,

wherein the joint portion includes a first joining layer and a second joining layer disposed below the first

joining layer, and

wherein the conductive layer is disposed between the first joining layer and the second joining layer.

[0079] (Supplementary Note 5)

The plasma processing apparatus according to any one of Supplementary Notes 1 to 4,

wherein the conductive layer is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$.

[0080] (Supplementary Note 6)

The plasma processing apparatus according to Supplementary Note 5,

wherein a thickness of the conductive layer ranges from 5 μm to 2 mm.

[0081] (Supplementary Note 7)

The plasma processing apparatus according to any one of Supplementary Notes 1 to 6,

wherein a frequency of the high frequency power ranges from 100 kHz to 100 MHz.

[0082] (Supplementary Note 8)

The plasma processing apparatus according to any one of Supplementary Notes 1 to 7,

wherein the heat transfer gas flow path is defined by a recess formed at an upper surface of the base and the joint portion covering the recess.

[0083] (Supplementary Note 9)

The plasma processing apparatus according to any one of Supplementary Notes 1 to 8,

wherein the base is formed of metal matrix composites (MMC), and

wherein the conductive layer is formed of aluminum.

[0084] (Supplementary Note 10)

A substrate support including

a base disposed in the plasma processing chamber,

an electrostatic chuck disposed at an upper portion of the base and including an attraction electrode,

a joint portion that joins the base and the electrostatic chuck, and

a conductive layer disposed between the base and the attraction electrode,

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed, and

wherein the conductive layer has a thickness equal to or larger than a skin depth at a frequency of a high frequency supplied to the base during plasma processing.

[0085] (Supplementary Note 11)

The substrate support according to Supplementary Note 10,

wherein the joint portion includes a conductive material and functions as the conductive layer.

[0086] (Supplementary Note 12)

The substrate support according to Supplementary Note 10,

wherein the conductive layer is disposed in the electrostatic chuck.

[0087] (Supplementary Note 13)

The substrate support according to Supplementary Note 10,

wherein the joint portion includes a first joining layer and a second joining layer disposed below the first joining layer, and

wherein the conductive layer is disposed between the first joining layer and the second joining layer.

[0088] (Supplementary Note 14)

The substrate support according to any one of

Supplementary Notes 10 to 13,

wherein the conductive layer is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}$ Ω·cm to $1.0\times10^{-4}$ Ω·cm.

[0089] (Supplementary Note 15)

The substrate support according to Supplementary Note 14,

wherein a thickness of the conductive layer ranges from 5 μm to 2 mm.

[0090] (Supplementary Note 16)

The substrate support according to any one of Supplementary Notes 10 to 15,

wherein a frequency of the high frequency ranges from 100 kHz to 100 MHz.

[0091] (Supplementary Note 17)

The substrate support according to any one of Supplementary Notes 10 to 16,

wherein the heat transfer gas flow path is defined by a recess formed at an upper surface of the base and the joint portion covering the recess.

[0092] (Supplementary Note 18)

The substrate support according to any one of Supplementary Notes 10 to 17,

wherein the base is formed of metal matrix composites (MMC), and

wherein the conductive layer is formed of aluminum.

[0093] (Supplementary Note 19)

A plasma processing apparatus including

a plasma processing chamber,

a base disposed in the plasma processing chamber,

a high frequency power supply electrically connected to the base,

an electrostatic chuck disposed at an upper portion of

the base and including an attraction electrode, and

a joint portion that joins the base and the electrostatic chuck,

wherein the electrostatic chuck has an upper surface at which an annular intermediate seal band and/or an outer peripheral seal band is formed, and

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed below the intermediate seal band and/or the outer peripheral seal band.

[0094] (Supplementary Note 20)

The plasma processing apparatus according to Supplementary Note 19,

wherein the base has the heat transfer gas flow path at a position immediately below the intermediate seal band and/or the outer peripheral seal band.

[0095] (Supplementary Note 21)

The plasma processing apparatus according to Supplementary Note 19 or 20,

wherein the electrostatic chuck supports a substrate by the intermediate seal band and/or the outer peripheral seal band, and has the upper surface at which a heat transfer gas is supplied to a space formed by the intermediate seal band and/or the outer peripheral seal band on and the substrate, and

wherein the heat transfer gas flow path is formed to have a width and a depth so that a thermal resistance of the intermediate seal band portion and/or the outer peripheral seal band portion is equal to a thermal resistance of the space portion.

[0096] (Supplementary Note 22)

A substrate support including

a base disposed in the plasma processing chamber,

an electrostatic chuck disposed at an upper portion of the base and including an attraction electrode, and

a joint portion that joins the base and the electrostatic chuck,

wherein the electrostatic chuck has an upper surface at which an annular intermediate seal band and/or an outer peripheral seal band is formed, and

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed below the intermediate seal band and/or the outer peripheral seal band.

[0097] (Supplementary Note 23)

The substrate support according to Supplementary Note 22,

wherein the base has the heat transfer gas flow path at a position immediately below the intermediate seal band and/or the outer peripheral seal band.

[0098] (Supplementary Note 24)

The substrate support according to Supplementary Note 22 or 23,

wherein the electrostatic chuck supports a substrate by the intermediate seal band and/or the outer peripheral seal band, and has the upper surface at which a heat transfer gas is supplied to a space formed by the intermediate seal band and/or the outer peripheral seal band on and the substrate, and

wherein the heat transfer gas flow path is formed to have a width and a depth so that a thermal resistance of the intermediate seal band portion and/or the outer peripheral seal band portion is equal to a thermal resistance of the space portion.

Reference Signs List

[0099] 1 PLASMA PROCESSING APPARATUS

10 PLASMA PROCESSING CHAMBER
11 SUBSTRATE SUPPORT
30 POWER SUPPLY
31 RF POWER SUPPLY
31a FIRST RF GENERATION UNIT
31b SECOND RF GENERATION UNIT
32 DC POWER SUPPLY
32a FIRST DC GENERATION UNIT
32b SECOND DC GENERATION UNIT
40 EXHAUST SYSTEM
111 MAIN BODY
111a CENTRAL REGION
111b ANNULAR REGION
112 RING ASSEMBLY
120 ETCHING TARGET FILM
130a, 130b INTERMEDIATE SEAL BAND
131 OUTER PERIPHERAL SEAL BAND
132a, 132b, 132c SPACE
1110 BASE
1110a FLOW PATH
1110b UPPER SURFACE
1110c LOWER SURFACE
1111 ELECTROSTATIC CHUCK
1111a CERAMIC MEMBER
1111b ELECTROSTATIC ELECTRODE
1112, 1112a, 1112b ADHESIVE LAYER
1113 CONDUCTIVE LAYER
11101a, 11101b DIFFUSION FLOW PATH
W SUBSTRATE

## CLAIMS

Claim. 1 A plasma processing apparatus comprising:

a plasma processing chamber;

a base disposed in the plasma processing chamber;

a high frequency power supply electrically connected to the base;

an electrostatic chuck disposed at an upper portion of the base and including an attraction electrode;

a joint portion that joins the base and the electrostatic chuck; and

a conductive layer disposed between the base and the attraction electrode,

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed, and

wherein the conductive layer has a thickness equal to or larger than a skin depth at a frequency of high frequency power output by the high frequency power supply.

Claim. 2 The plasma processing apparatus according to claim 1,

wherein the joint portion includes a conductive material and functions as the conductive layer.

Claim. 3 The plasma processing apparatus according to claim 1,

wherein the conductive layer is disposed in the electrostatic chuck.

Claim. 4 The plasma processing apparatus according to claim 1,

wherein the joint portion includes a first joining layer and a second joining layer disposed below the first

joining layer, and

wherein the conductive layer is disposed between the first joining layer and the second joining layer.

Claim. 5 The plasma processing apparatus according to claim 1,

wherein the conductive layer is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$.

Claim. 6 The plasma processing apparatus according to claim 5,

wherein a thickness of the conductive layer is 5 μm to 2 mm.

Claim. 7 The plasma processing apparatus according to claim 1,

wherein a frequency of the high frequency power ranges from 100 kHz to 100 MHz.

Claim. 8 The plasma processing apparatus according to claim 1,

wherein the heat transfer gas flow path is defined by a recess formed at an upper surface of the base and the joint portion covering the recess.

Claim. 9 The plasma processing apparatus according to claim 1,

wherein the base is formed of metal matrix composites (MMC), and

wherein the conductive layer is formed of aluminum.

Claim. 10 A substrate support comprising:

a base disposed in the plasma processing chamber;

an electrostatic chuck disposed at an upper portion of the base and including an attraction electrode;

a joint portion that joins the base and the electrostatic chuck; and

a conductive layer disposed between the base and the attraction electrode,

wherein the base has an upper surface at which a heat transfer gas flow path defined by the base and the joint portion is formed, and

wherein the conductive layer has a thickness equal to or larger than a skin depth at a frequency of a high frequency supplied to the base during plasma processing.

Claim. 11 The substrate support according to claim 10,

wherein the joint portion includes a conductive material and functions as the conductive layer.

Claim. 12 The substrate support according to claim 10,

wherein the conductive layer is disposed in the electrostatic chuck.

Claim. 13 The substrate support according to claim 10,

wherein the joint portion includes a first joining layer and a second joining layer disposed below the first joining layer, and

wherein the conductive layer is disposed between the first joining layer and the second joining layer.

Claim. 14 The substrate support according to claim 10,

wherein the conductive layer is made of a nonmagnetic material and is formed of a material having a volume resistivity of $1.0\times10^{-6}\ \Omega\cdot cm$ to $1.0\times10^{-4}\ \Omega\cdot cm$.

Claim. 15 The substrate support according to claim 14, wherein a thickness of the conductive layer is 5 μm to 2 mm.

Claim. 16 The substrate support according to claim 10, wherein a frequency of the high frequency power ranges from 100 kHz to 100 MHz.

Claim. 17 The substrate support according to claim 10, wherein the heat transfer gas flow path is defined by a recess formed at an upper surface of the base and the joint portion covering the recess.

Claim. 18 The substrate support according to claim 10, wherein the base is formed of metal matrix composites (MMC), and
wherein the conductive layer is formed of aluminum.