Appeal Decision

Appeal No. 2016-15984

Tokyo, Japan
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The case of appeal against the examiner's decision of refusal No. 2012-132838, entitled "Plasma Processing Apparatus" (the application published on February 14, 2013, Japanese Unexamined Patent Application Publication No. 2013-33940) has resulted in the following appeal decision:

Conclusion
The appeal of the case was groundless.

Reason
1. History of the procedures and the Invention
The application was filed on June 12, 2012 (priority claim: July 7, 2011), and reasons for refusal were notified on January 12, 2016 and a written opinion and written amendment were submitted on March 18, 2016; however, a decision of refusal was made on July 19, 2016. Against this, an appeal against the examiner's decision of refusal was requested on October 26, 2016 and a written amendment was submitted at the same time; and a written amendment was submitted on December 1, 2016. Then, reasons for refusal (hereinafter, referred to as the "reasons for refusal by the body") were notified by the body on August 10, 2017, and the written opinion and written amendment were submitted on October 12, 2017.
The inventions according to Claims 1 and 2 (hereinafter, referred to as "Invention 1" and "Invention 2") are acknowledged as follows, as specified by the matters described in Claims 1 and 2 of the scope of claims for patent amended in the written amendment submitted on October 12, 2017.

"[Claim 1]

A plasma processing apparatus comprising:
a processing container defining a processing space;
a gas supply unit supplying a processing gas to the processing space;
an introduction unit introducing energy for generating plasma of the processing gas;
a holding member for holding a substrate to be processed, which has a dielectric material surface and an end surface partially including a flat end surface and is provided in the processing space; and
a focus ring provided so as to enclose the end surface of the holding member, which has an inner wall surface partially including a flat wall surface facing the flat end surface of the holding member; wherein
a gap between the end surface of the holding member and the inner wall surface of the focus ring is larger than 0 and equal to or smaller than three times the length (λ_D) of Debye represented by Formula (1):
[Expression 1]

$$\lambda_D(cm) = 7.43\times10^2\sqrt{\frac{T_e(eV)}{n_0(cm^{-3})}} \cdots \quad (1)$$

'T_e' in Formula (1) is an electron temperature in the gap and 'n_o' is an electron density in the gap;
the focus ring includes a first region including an inner edge of the focus ring and a second region outside the first region;
the first region is provided along an extended surface of an upper surface of the holding member;
the second region is provided above the upper surface of the holding member; and
the first region includes a part directly contacted by the substrate to be processed, and by contact of the substrate to be processed with the directly contacted part, the partial region in the first region is covered without generating a gap with the substrate to be processed and part of the gap between the holding member and focus ring is closed."
"[Claim 2]
The plasma processing apparatus according to Claim 1, wherein a gap between the end surface of the holding member and the inner wall surface of the focus ring is larger than 0 and equal to or smaller than 350μm."

2 Reasons for refusal of the body
Meanwhile, the summary of the reasons for refusal notified by the body on August 10, 2017 (the reasons for refusal by the body) is as follows:
"1 The inventions relating to the following claims in this application could have been easily made by a person ordinarily skilled in the art of the inventions based on the inventions described in the following publications that had been distributed in Japan or a foreign country or inventions that had become available to the public through electric communication lines prior to the filing of the application. Thus, the appellant should

not be granted a patent for the inventions under the provisions of Article 29(2) of the Patent Act.

Description (For cited documents, etc., refer to 'List of Cited Documents, etc.')
*Reason 1
*Claims 1 and 2
*Cited Documents 1-5

*Remarks
*Examination when Cited Reference 1 is the main cited citation
<omitted>
*Examination when Cited Reference 2 is the main cited citation

Refer to Claim 1, Claim 8, [0008], [0028], [0031]-[0055], and FIGS. 1-2, etc. of Cited Reference 2.

In [0028] of Cited Reference 2, it is described that a gap between the electrostatic chuck and the focus ring is made equal to or larger than 0.05 mm and equal to or smaller than 0.4 mm so as to prevent entry of plasma.

Then, it is recognized that the size of the gap sufficient to prevent plasma from entering in the Cited Reference 2 corresponds to one within three times or smaller the length of Debye (λ_D).

In addition, regarding the point that the holding member 'has an end surface partially including a flat end surface' and the focus ring is 'partially including a flat wall surface facing the flat end surface of the holding member,' refer to descriptions of [0018], [0022], and FIG. 3 of Cited Reference 3, [0020], [0028]-[0029], FIG. 3, and FIG. 6 of Cited Reference 4, [0037], [0050], FIG. 1, FIG. 3 of Cited Reference 5, etc.

<List of Cited Documents, etc.>
1. Japanese Unexamined Patent Application Publication No. 2004-200353>
2. Japanese Unexamined Patent Application Publication No. 2011-108816>
3. Japanese Unexamined Patent Application Publication No. H9-289201
4. Japanese Unexamined Patent Application Publication No. H7-106316
5. Japanese Unexamined Patent Application Publication No. H8-107139

<remainder omitted>"

3. Description of the Cited Document and the Cited Invention

(1) Cited Document 1 (Japanese Unexamined Patent Application Publication No. 2011-108816) which was cited as "Cited Reference 2" in the reasons for refusal of the body and was distributed or made publicly available through an electric telecommunication line in Japan before the priority date of the present application includes the following description with drawings about "Substrate Mounting Table of Substrate Processing Apparatus" (title of the invention). (The underlines have been added by the body. The same shall apply hereinafter.)

"[Claim 1]

A substrate mounting table of a substrate processing apparatus comprising: a base portion; a disk-shaped electrostatic chuck adhered to an upper flat surface of the base portion by an adhesive layer and supporting a substrate by a circular attracting surface; and an annular focus ring arranged around the electrostatic chuck to surround the substrate and to cover an outer peripheral portion of the upper flat surface of the base portion; wherein the electrostatic chuck has a two-layer structure including an upper disk portion and a lower disk portion having a diameter larger than that of the upper disk portion; and an outer peripheral portion of the lower disk portion and an outer peripheral portion of the adhesive layer adhering the lower disk portion to the base portion are covered with the focus ring."

<omitted>

[Claim 8]

The substrate mounting table of a substrate processing apparatus according to any one of Claims 1 to 7, wherein a gap (C) between an outer peripheral surface of the upper disk portion of the electrostatic chuck and an inner peripheral surface of the focus ring ranges from 0.05 to 0.4 mm."

"[0008]

Since there is a gap between the electrostatic chuck 72 and the focus ring 75 in such a conventional substrate mounting table, plasma enters the gap and a gap between the wafer W and the focus ring 75. Accordingly, there is a problem in that the adhesive layer 73 formed of an organic material is worn by irradiation of the plasma. Further, a surface 71a of the base portion 71 between the electrostatic chuck 72 and the focus ring 75 is exposed. The plasma is irradiated on the exposed surface 71a and the thermally sprayed film is worn. Then, when the aluminum of the base portion 71 is exposed, abnormal discharge (arcing) may occur. The wear of the adhesive layer 73 and the occurrence of the abnormal discharge exert a bad influence on the functions of the substrate mounting table, thereby shortening a life span of the substrate mounting table."

"[0028]

According to the substrate mounting table of a substrate processing apparatus according to Claim 8, a gap (C) between an outer peripheral surface of the upper disk portion of the electrostatic chuck and an inner peripheral surface of the focus ring ranges from 0.05 mm to 0.4 mm and therefore, it is possible to prevent the plasma from entering the gap between the electrostatic chuck and the focus ring."

"[0031]

FIG. 1 is a sectional view schematically showing a configuration of a substrate processing apparatus including a substrate mounting table in accordance with an embodiment of the present invention. This substrate processing apparatus performs a plasma etching process on a wafer for semiconductor devices (hereinafter, simply referred to as the 'wafer') as a substrate.

[0032]

In FIG. 1, a substrate processing apparatus 10 has a chamber 11 for accommodating a wafer W, and a cylindrical substrate mounting table (hereinafter, referred to as the 'susceptor') 12 for mounting the wafer W thereon is provided in the chamber 11. In the substrate processing apparatus 10, a side exhaust path 13 is defined by an inner sidewall of the chamber 11 and a side surface of the susceptor 12. A gas

exhaust plate 14 is provided in the side exhaust path 13.
[0033]
The gas exhaust plate 14 is a plate-shaped member having a large number of through holes and functions as a partition plate for dividing the inside of the chamber 11 into an upper portion and a lower portion. In an inner upper portion (hereinafter, referred to as the 'processing chamber') 15 of the chamber 11 defined by the gas exhaust plate 14, plasma is generated as will be described later. Further, a gas exhaust pipe 17 for discharging gas in the chamber 11 is connected to an inner lower portion (hereinafter, referred to as the 'gas exhaust space (manifold)') 16 of the chamber 11. The gas exhaust plate 14 prevents the plasma from leaking into the manifold 16 by blocking or reflecting the diffusion of the plasma generated in the processing chamber 15.
[0034]
A turbo molecular pump (TMP) and a dry pump (DP) (both of which are not shown) are connected to the gas exhaust pipe 17, and the chamber 11 can be vacuum exhausted to a predetermined pressure by the pumps. The pressure of the chamber 11 is controlled by an automatic pressure control (APC) valve (not shown).
[0035]
A first high frequency power supply 18 is connected to the susceptor 12 in the chamber 11 via a first matching unit 19. Further, a second high frequency power supply 20 is connected to the susceptor 12 via a second matching unit 21. The first high frequency power supply 18 applies a high frequency power for bias with a relatively low frequency, e.g., 2 MHz, to the susceptor 12. The second high frequency power supply 20 applies a high frequency power for plasma generation with a relatively high frequency, e.g., 60 MHz, to the susceptor 12. Accordingly, the susceptor 12 serves as a lower electrode. Further, the first matching unit 19 and the second matching unit 21 maximize an efficiency of the high frequency power applied to the susceptor 12 by reducing the reflection of the high frequency power from the susceptor 12.
[0036]
An electrostatic chuck 23 having an electrostatic electrode plate 22 therein is placed on the susceptor 12. The electrostatic chuck 23 is formed of ceramic, and has a two-layer structure in which a lower disk portion has a larger diameter than that of an upper disk portion.
[0037]
A DC power supply 24 is connected to the electrostatic electrode plate 22. When a positive DC voltage is applied to the electrostatic electrode plate 22, a negative potential is generated at a surface (hereinafter, referred to as the 'backside') of the wafer W facing the electrostatic chuck 23. Accordingly, a potential difference is generated between the electrostatic electrode plate 22 and the backside of the wafer W, so that the wafer W is attracted and held on the electrostatic chuck 23 by Coulomb force or Johnsen-Rahbek force caused by the potential difference.
[0038]
A focus ring 25 is arranged to surround the wafer W attracted and held on the electrostatic chuck 23. The focus ring 25 is formed of, e.g., silicon (Si), silicon carbide (SiC), or the like.
[0039]
Inside the susceptor 12, an annular coolant path 26 extending in a circumferential

direction, for example, is provided. A low-temperature coolant, e.g., cooling water or Galden (registered trademark), is circulated and supplied into the coolant path 26 from a chiller unit (not shown) via a coolant line 27. The susceptor 12 that has been cooled by the coolant cools the wafer W and the focus ring 25 through the electrostatic chuck 23.

[0040]

Heat transfer gas supply holes 28 are formed to be opened at a portion (hereinafter, referred to as the 'attracting surface') of the electrostatic chuck 23 on which the wafer W is attracted and held. The heat transfer gas supply holes 28 are connected to a heat transfer gas supply unit (not shown) via a heat transfer gas supply line 29. The heat transfer gas supply unit supplies helium (He) gas serving as a heat transfer gas to a gap between the attracting surface and the backside of the wafer W through the heat transfer gas supply holes 28. The He gas supplied to the gap between the attracting surface and the backside of the wafer W effectively transfers the heat of the wafer W to the electrostatic chuck 23.

[0041]

A shower head 30 is arranged at a ceiling portion of the chamber 11 to face the susceptor 12. The shower head 30 has an upper electrode plate 31, a cooling plate 32 for detachably holding the upper electrode plate 31, and a cover 33 for covering the cooling plate 32. The upper electrode plate 31 is formed of a disk-shaped member having a number of gas holes 34 formed therethrough in its thickness direction and is made of, e.g., silicon as a semiconductor material. Further, a buffer room 35 is provided in the cooling plate 32, and a gas inlet pipe 36 is connected to the buffer room 35.

[0042]

Further, a DC power supply 37 is connected to the upper electrode plate 31 of the shower head 30, and a negative DC voltage is applied to the upper electrode plate 31. In this case, the upper electrode plate 31 emits secondary electrons by collision of positive ions, thereby preventing reduction in electron density above the wafer W in the processing chamber 15. The emitted secondary electrons flow from a region above the wafer W to a ground electrode (ground ring) 38 formed of a semiconductor material such as silicon carbide or silicon and provided to surround the side surface of the susceptor 12 in the side exhaust path 13.

[0043]

In the plasma processing apparatus 10 having the above configuration, a processing gas supplied from the processing gas inlet pipe 36 to the buffer room 35 is introduced into the processing chamber 15 through the gas holes 34. The introduced processing gas is excited by a high frequency power for plasma generation applied to the processing chamber 15 from the second high frequency power supply 20 through the susceptor 12 and is converted into plasma. Ions in the plasma are attracted toward the wafer W by the high frequency power for bias applied to the susceptor 12 from the first high frequency power supply 18, thereby performing a plasma etching process on the wafer W.

[0044]

An operation of each component of the substrate processing apparatus 10 is controlled by a CPU of a controller (not shown) of the substrate processing apparatus 10 according to a program corresponding to a plasma etching process.

[0045]

FIG. 2 illustrates a partial sectional view showing the substrate mounting table of FIG. 1.

[0046]

As shown in FIG. 2, the susceptor 12 mainly includes a base portion (hereinafter, referred to as the "metal base") 41, the disk-shaped electrostatic chuck 23 adhered to an upper front surface of the metal base 41 via an adhesive layer 42 and having a circular attracting surface for supporting the wafer W, and the annular focus ring 25 arranged around the electrostatic chuck 23 to surround the wafer W.

[0047]

The electrostatic chuck 23 has a two-layer structure (hat shape) in which a lower disk portion 23a has a larger diameter than that of an upper disk portion 23b. The thickness of each of the lower disk portion 23a and the upper disk portion 23b is, e.g., 1 mm. The metal base 41 is a cylindrical member formed of aluminum covered with a thermally sprayed film of ceramic. The metal base 41 has at its upper front surface a depression 41a into which the lower disk portion 23a of the electrostatic chuck 23 is fitted. The lower disk portion 23a of the electrostatic chuck 23 is fitted into the depression 41a of the metal base 41 and adhered to a bottom flat surface of the depression 41a by the adhesive layer 42.

[0048]

The focus ring 25 is mounted on an upper flat surface 41b surrounding the depression 41a of the metal base 41 to cover the upper flat surface 41b. An inner peripheral portion of the focus ring 25 is protruded inwardly circumferentially from an inner peripheral end of the upper flat surface 41b of the metal base 41. An outer peripheral portion of the lower disk portion 23a of the electrostatic chuck 23 fitted into the depression 41a and an outer peripheral portion of the adhesive layer 42 are covered with the focus ring 25. That is, a fitting portion of the lower disk portion 23a of the electrostatic chuck 23 and the depression 41a of the metal base 41 is covered with the focus ring 25. In this case, an overlapping width (F) between the lower disk portion 23a of the electrostatic chuck 23 and the focus ring 25 in a radial direction of the electrostatic chuck 23 is equal to or larger than, e.g., 0.5 mm. An effect of preventing the plasma from entering is increased by making the overlapping width (F) equal to or larger than 0.5 mm.

[0049]

A sum of the thickness of the lower disk portion 23a of the electrostatic chuck 23 and the thickness of the adhesive layer 42 is slightly smaller than the depth of the depression 41a of the metal base 41. Accordingly, there is a gap D between a lower flat surface of the focus ring 25 mounted on the upper flat surface 41b surrounding the depression 41a of the metal base 41 and an upper flat surface of the lower disk portion 23a of the electrostatic chuck 23. The gap (D) is equal to or smaller than, e.g., 0.4 mm. If the gap D exceeds 0.4 mm, an effect of preventing entry of the plasma cannot be sufficiently obtained.

[0050]

By providing the gap between the lower flat surface of the focus ring 25 mounted on the upper flat surface 41b of the metal base 41 and the lower disk portion 23a of the electrostatic chuck 23, manufacturing errors in the manufacture of the components can be absorbed, thereby ensuring easy assembly. For example, if the upper flat surface 41b of the metal base 41 is intended to be flush with the upper flat surface of the lower disk portion 23a of the electrostatic chuck 23, and even when the focus ring 25 is intended to be mounted so as to be in contact with both the upper flat surface 41b of the metal base 41 and the upper flat surface of the lower disk portion 23a of the electrostatic chuck 23 at the same time, the upper flat surface 41b and the upper flat surface of the lower disk portion 23a will not be flush with each other due to dimension errors. Accordingly, it is difficult to achieve favorable assembly.

[0051]

The wafer W is a circular plate-shaped member made of, e.g., silicon. The wafer W partially overlaps with the focus ring 25 in the vertical direction. That is, an outer peripheral portion of the wafer W overlaps with an inner peripheral portion of the focus ring 25 in the vertical direction. An overlapping width (A) at one overlapping portion in a radial direction of the wafer W ranges from 0.5 mm to 1.5 mm. If the overlapping width (A) is smaller than 0.5 mm, the effect of preventing entry of the plasma is insufficient. If the overlapping width (A) is larger than 1.5 mm, a contact area between the electrostatic chuck 23 and the wafer W becomes relatively small, thereby reducing heat transfer efficiency in control of the temperature of the wafer W. If the overlapping width (A) ranges from 0.5 mm to 1.5 mm, it is possible to prevent entry of the plasma into the gap between the wafer W and the focus ring 25 without reduction in heat transfer efficiency.

[0052]

A gap (B) between the wafer W and the focus ring 25 at the overlapping portion of the wafer W and the focus ring 25 is equal to or smaller than, e.g., 0.4 mm. If the gap is larger than 0.4 mm, the effect of preventing entry of the plasma is insufficient. If the gap between the wafer W and the focus ring 25 is equal to or smaller than 0.4 mm, it is possible to effectively prevent entry of the plasma. In this case, the lower flat surface of the wafer W may be in contact with the upper flat surface of the focus ring 25, but it is preferable to ensure a small gap of, e.g., about 0.1 mm in order to avoid damage due to stress caused by a vertical resistance force received from the upper flat surface of the focus ring 25.

[0053]

A gap (C) between an outer peripheral surface of the upper disk portion 23b of the electrostatic chuck 23 and an inner peripheral surface of the focus ring 25 is equal to or smaller than, e.g., 0.4 mm, preferably, equal to or larger than 0.05 mm and equal to or smaller than 0.4 mm. If the gap (C) exceeds 0.4 mm, the effect of preventing the plasma from entering is reduced. Further, if the gap (C) is smaller than 0.05 mm, the outer peripheral surface of the upper disk portion 23b of the electrostatic chuck 23 and the inner peripheral surface of the focus ring 25 may be in contact with each other, thereby causing damage to the surfaces. If the gap (C) ranges from 0.05 mm to 0.4 mm, it is possible to prevent the plasma from entering the gap while preventing damage due to contact. The same is also applied to a gap (D).

[0054]

According to the present embodiment, the electrostatic chuck 23 includes the upper disk portion 23b and the lower disk portion 23a having a larger diameter than that of the upper disk portion 23b, the lower disk portion 23a is fitted into the depression 41a of the metal base 41, and a fitting portion is covered with the focus ring 25. Accordingly, the surface of the metal base 41 (bottom surface of the depression 41a) and the outer peripheral portion of the adhesive layer 42 can be positioned below the fitting portion 41c of the lower disk portion 23a and the depression 41a, thereby extending a plasma path toward the surface of the metal base 41 and the outer peripheral portion of the adhesive layer 42. Consequently, it is possible to prevent the plasma from reaching the surface of the metal base 41 and the outer peripheral portion of the adhesive layer 42. As a result, it is possible to prevent the wear of the adhesive layer 42 and the occurrence of arcing on the surface of the metal base 41, without adding another component.

[0055]

In other words, in accordance with the present embodiment, the wafer W partially overlaps with the focus ring 25 in the vertical direction. The gap (B) formed between the wafer W and the focus ring 25 and extended in the horizontal direction, the gap (C) formed between the outer peripheral surface of the upper disk portion 23b of the electrostatic chuck 23 and the inner peripheral surface of the focus ring 25 and extended in the vertical direction, and the gap (D) formed between the lower flat surface of the focus ring 25 and the upper flat surface of the lower disk portion 23a of the electrostatic chuck 23 in the horizontal direction are made to be equal to or smaller than, e.g., 0.4 mm. Accordingly, the gaps formed between the wafer W and the focus ring 25 and between the electrostatic chuck 23 and the focus ring 25 to communicate with a space above the wafer W are made to have a so-called labyrinth structure. Thus, it is possible to prevent plasma in performing a plasma process on the wafer W from reaching the surface of the metal base 41 or the adhesive layer 42 through the gaps, and to prevent the wear of the adhesive layer 42 and the occurrence of arcing on the surface of the metal base 41, thereby preventing damage to the surfaces. Further, it is also possible to prevent contamination of the metal and the generation of particles due to arcing."

*FIG. 2 illustrates a partial sectional view showing the substrate mounting table according to an embodiment of the invention described in Cited Document 1. Then, from this figure and the above excerpted description, especially the description of [0052] "A gap (B) between the wafer W and the focus ring 25 at the overlapping portion of the wafer W and the focus ring 25 is equal to or smaller than, e.g., 0.4 mm. If the gap is larger than about 0.4 mm, the effect of preventing entry of the plasma is insufficient. If the gap between the wafer W and the focus ring 25 is equal to or smaller than 0.4 mm, it is possible to effectively prevent entry of the plasma. In this case, the lower flat surface of the wafer W may be in contact with the upper flat surface of the focus ring 25," the following structure can be understood:

a structure in which:

an annular focus ring arranged around the electrostatic chuck includes an inner peripheral portion including an inner peripheral surface of the focus ring, and an outer peripheral portion outside the inner peripheral portion;

an upper flat surface of the inner peripheral portion is provided along an extended surface of the upper surface of the electrostatic chuck;

an upper flat surface of the outer peripheral portion is provided above the upper surface of the electrostatic chuck;

the upper flat surface of the inner peripheral portion includes a part contacted by the lower flat surface of a wafer, and by making the wafer contact the contacted part, a partial region in the upper flat surface of the inner peripheral portion is covered without generating a gap with the wafer and part of the gap between the electrostatic chuck and the focus ring is closed.

Accordingly, in light of the above description, it is recognized that in Cited Document 1, the following invention (hereinafter, referred to as "the Cited Invention") is described:

"A substrate processing apparatus which performs a plasma etching process on a wafer for semiconductor devices as a substrate comprises:

a chamber for accommodating a circular plate-shaped wafer made of silicon for semiconductor devices;

a cylindrical substrate mounting table (hereinafter, referred to as the 'susceptor') for mounting the wafer for semiconductor devices thereon; and

a shower head arranged at a ceiling portion of the chamber to face the susceptor; wherein

(A) the shower head includes: an upper electrode plate formed of a disk-shaped member having a number of gas holes formed therethrough in its thickness direction; a cooing plate detachably holding the upper electrode plate; and a cover for covering the cooling plate: and a buffer room is provided within the cooling plate, a processing gas inlet pipe is connected to the buffer room; a processing gas supplied from the processing gas inlet pipe to the buffer room is introduced into an inner upper portion (hereinafter, referred to as the 'processing chamber') of the chamber through gas holes;

(B) the susceptor comprising:

a base portion;

a disk-shaped electrostatic chuck adhered to an upper flat surface of the base portion by an adhesive layer and supporting a substrate by a circular attracting surface;

and an annular focus ring arranged around the electrostatic chuck to surround the substrate and to cover an outer peripheral portion of the upper flat surface of the base portion; wherein

the electrostatic chuck is formed of ceramic and has a two-layer structure including an upper disk portion and a lower disk portion having a diameter larger than that of the upper disk portion; the thickness of each of the lower disk portion and the upper disk portion is 1 mm; and

an outer peripheral portion of the lower disk portion and an outer peripheral portion of the adhesive layer adhering the lower disk portion to the base portion are covered with the focus ring;

(C) the wafer partially overlaps with the focus ring in the vertical direction; that is, an outer peripheral portion of the wafer overlaps with an inner peripheral portion of the focus ring in the vertical direction; an overlapping width (A) at one overlapping portion in a radial direction of the wafer is set in the range from 0.5 mm to 1.5 mm and thereby it is possible to prevent the plasma from entering the gap between the wafer and the focus ring without reduction in heat transfer efficiency;

at the overlapping portion of the wafer and the focus ring, the lower flat surface of the wafer is in contact with the upper flat surface of the focus ring; and

a gap (C) between an outer peripheral surface of the upper disk portion of the electrostatic chuck and an inner peripheral surface of the focus ring ranges from 0.05 mm to 0.4 mm; and it is possible to prevent the plasma from entering the gap while preventing damage due to contact;

(D) the annular focus ring arranged around the electrostatic chuck includes an inner peripheral portion including an inner peripheral surface of the focus ring, and an outer peripheral portion outside the inner peripheral portion;

an upper flat surface of the inner peripheral portion is provided along an extended surface of the upper surface of the electrostatic chuck;

an upper flat surface of the outer peripheral portion is provided above the upper surface of the electrostatic chuck;

the upper flat surface of the inner peripheral portion includes a part contacted by the lower flat surface of the wafer, and by making the wafer contact the contacted part, a partial region in the upper flat surface of the inner peripheral portion is covered without generating a gap with the wafer and part of the gap between the electrostatic chuck and the focus ring is closed; and

(E) a second high frequency power supply is connected to the susceptor via a second matching unit, the second high frequency power supply applies a high frequency power for plasma generation with a relative high frequency, e.g., 60 MHz, to the susceptor, and an introduced processing gas is excited by the high frequency power for plasma generation applied to the processing chamber from the second high frequency power supply through the susceptor and is converted into plasma."

(2) Cited Document 2 (Japanese Unexamined Patent Application Publication No. H09-289201) which was cited as "Cited Reference 3" in the reasons for refusal of the body and was distributed or made publicly available through an electric telecommunication line in Japan before the priority date of the present application, includes the following description with drawings about "Plasma Processing Apparatus" (title of the invention).

"[0018] <u>The planar form of the electrostatic chuck 11 has a shape similar to the outside shape of the wafer W and has a slightly smaller size than the wafer W</u>. In addition, to the peripheral portion of the upper surface of the ceramic 13 in the electrostatic chuck 11, a polyimide tape 14 as a freely adhesively/peelably supporting member is adhered so as to form a shape similar to the outside shape of the wafer W, as shown in FIG. 3. The thickness of the polyimide tape 14 is 50 μm and the width d thereof is 3 mm as shown in FIG. 4. (The hatched portion in FIG. 4 indicates the polyimide tape 14.)"

"[0022] <u>Around the electrostatic chuck 11</u> on the upper surface outer peripheral edge of the susceptor 6, <u>the focus ring 29</u> for improving the incidence efficiency of ions in the plasma to the wafer W <u>is provided</u> so as to surround the electrostatic chuck 11."

*FIG. 2 illustrates a sectional side view of the electrostatic chuck in the etching device according to an embodiment of the invention described in the Cited Document 2, and FIG. 3 is a perspective view of the electrostatic chuck. Then, from the above excerpted description and those figures, the following structure can be understood:

a structure comprising:

a circular plate-shaped wafer W having an end surface partially including a flat end surface;

an electrostatic chuck (11) for holding the wafer W, which has a planar form that is of a shape similar to the outside shape of the wafer W, which has a slightly smaller size than that of the wafer W, and which has a surface and an end surface partially including a flat end surface; and a focus ring (29) provided so as to enclose the end surface of the electrostatic chuck (11), which has an inner wall surface partially including a flat wall surface facing the flat end surface of the electrostatic chuck (11).

(3) Cited Document 3 (Japanese Unexamined Patent Application Publication No. H07-106316) which was cited as "Cited Reference 4" in the reasons for refusal of the body and was distributed or made publicly available through an electric telecommunication line in Japan before the priority date of the present application, includes the following description with drawings about "Plasma Processing Apparatus" (title of the invention).
"[0020] On the upper surface of the mounting table 3, a plasma concentration ring (focus ring) 6 consisting of an insulator such as ceramic or quartz is provided around the wafer W so as to surround the wafer W. The focus ring 6 is formed so as to have a shape similar to the outside shape of the wafer W as shown in FIG. 3 and is also inclined to be raised from the inner peripheral edge toward the outer peripheral edge. As shown in FIG. 4, for an 8-inch wafer, for example, the following settings are made: the ring width a of the focus ring 6 is 30 mm; the height b of the outer peripheral edge for the wafer surface is 2 mm; the distance c between the wafer W and the ring inner edge is 0.5 mm; and the height d of the inner peripheral edge for the wafer surface is 1.5 mm. The focus ring 6 is for attracting the electric force lines in the chamber 2 to the central portion of the chamber 2, and in this example, it is made of an insulator. However, it is not limited to being constituted of an insulator but can be constituted of a high resistor (including a conductive high resistor and a material having a resistance corresponding to that of a semiconductor)."

"[0028] In this embodiment, the upper surface of the focus ring is an inclined surface. However, even if a plurality of stepped portions are formed as shown in FIG. 6(a), an L-shaped focus ring 6 is formed as shown in FIG. 6(b), or the outer portion of the focus ring 6 is inclined while the inner portion of the focus ring 6 is formed flat as shown in FIG. 6(c), the same effect can be obtained. The inner portion of the focus ring 6 may be lower than or level with the surface of the wafer W. It suffices if the height of the focus ring 6 is appropriately set in accordance with the density of the plasma and the like so that the flatness at the peripheral portion of the wafer W can be ensured.
[0029] If the focus ring 6 is formed such that its outer portion is higher than its inner portion, it is preferable, because the flatness of the peripheral portion of the lower surface of the plasma is improved. However, the present invention does not necessarily limit the relationship in height between the outer and inner sides of the upper surface of the focus ring 6 as described above. From the viewpoint of obtaining a high plasma concentration effect, the upper surface of the focus ring 6 may be a flat surface parallel to the wafer W, so long as it is higher than the surface of the wafer W."

*FIG. 1 and FIG. 2 illustrate a sectional view showing the entire configuration of a plasma processing apparatus e.g., an etching device according to the embodiment of the invention described in the Cited Document 3 and a partially broken perspective view; and FIG. 3 illustrates an exploded perspective view showing the mounting table and focus ring. Then, from the above excerpted description and those figures, the following structure can be understood:

a structure comprising:

a circular plate-shaped wafer W having an end surface partially including a flat end surface;

a mounting table (3) for holding the wafer W, which has a surface and an end surface partially including a flat end surface; and

a plasma concentration ring (focus ring) (6) provided so as to enclose the end surface of the mounting table (3), which has an inner wall surface partially including a flat wall surface facing the flat end surface of the mounting table (3).

(4) Cited Document 4 (Japanese Unexamined Patent Application Publication No. H08-107139) which was cited as "Cited Reference 5" in the reasons for refusal of the body and was distributed or made publicly available through an electric telecommunication line in Japan before the priority date of the present application, includes the following description with drawings about "Insulating Ring Member and Semiconductor Manufacturing Device Provided Therewith" (title of the invention):

"[Claim 1] An insulating ring member used in a processing chamber where a semiconductor wafer is processed with plasma, which is installed on a sample table for holding the semiconductor wafer and has an inner peripheral surface corresponding to a side surface of the semiconductor wafer: wherein a gap between the side surface of the semiconductor wafer and the inner peripheral surface is equal to or smaller than 1 mm when the semiconductor wafer is mounted on the sample table.

<omitted>

[Claim 3] An insulating ring member according to Claim 1 or 2, wherein the insulating ring member itself is formed of quartz."

"[0037] The experimental results of test data shown in FIG. 3 are described by referring to FIG. 1 and FIG. 3: a gap t between the inner peripheral surface 3a of the insulating ring member 3 and the side surface 1a of the wafer 1 is used as a parameter, and the amount of abrasion due to the etching of the oxide film adhered to the side surface 1a of the wafer 1 is measured while changing the gap t to 0.5 mm, 1.0 mm, 1.5 mm, and 2.0 mm; and as a result, it was found that the amount of abrasion of the oxide film becomes zero when the gap t is 0.5 mm or 1.0 mm."

"[0050] In addition, the insulating ring member according to the present invention can be applied to either an orientation flat type wafer or a notch-type wafer."

*FIG. 1 (a) and (b) are the plan view and sectional view of an embodiment of the structure of the insulating ring member of the invention described in Cited Document 4.
Then, from the above excerpted description and those figures, the following structure can be understood:

a structure comprising:

an orientation flat type wafer (1);

an electrostatic chuck (sample table) (2) for holding the orientation flat type wafer W (1), which has a surface and an end surface partially including a flat end surface; and

an insulating ring member (3) provided so as to enclose the end surface of the electrostatic chuck (sample table) (2), which has an inner wall surface partially including a flat wall surface facing the flat end surface of the electrostatic chuck (sample table) (2).

4 Judgment by the body

(1) Regarding the inventive step of Claim 1

A Comparison

The Invention 1 and the Cited Invention are compared.

(A) The "processing chamber," "chamber," "shower head," "'a susceptor' to which 'a second high frequency power supply is connected via a second matching unit' and through which 'an introduced processing gas' is 'excited by the high frequency power for plasma generation applied to the processing chamber' and is converted into 'a plasma,'" "wafer," "electrostatic chuck," "ceramic," "upper flat surface of the inner peripheral portion' 'of the focus ring,'" and "'upper flat surface of the outer peripheral portion' 'of the focus ring'" in the Cited Invention correspond to the "processing space," "processing container," "gas supply unit supplying a processing gas to the processing space," "introduction unit introducing energy for generating plasma of the processing gas," "substrate to be processed," "holding member," "dielectric material," "first region including an inner edge of the focus ring," and "'second region' 'of the focus ring'" in Invention 1, respectively.

(B) The "substrate processing apparatus which performs a plasma etching process on a wafer for semiconductor devices as a substrate" of the Cited Invention corresponds to the "plasma processing apparatus" of Invention 1 except for the following different features 1 and 2.

Therefore, it can be said on the basis of the above correspondence relation that the corresponding features and different features between the Invention 1 and the Cited Invention are as follows:

<Corresponding Features>

"A plasma processing apparatus comprising:

a processing container defining a processing space;

a gas supply unit supplying a processing gas to the processing space;

an introduction unit introducing energy for generating plasma of the processing gas;

a holding member for holding a substrate to be processed, which has a dielectric material surface and an end surface and is provided in the processing space; and

a focus ring provided so as to enclose the end surface of the holding member, which has an inner wall surface; wherein

the focus ring includes a first region including an inner edge of the focus ring and a second region outside the first region;

the first region is provided along an extended plane of an upper surface of the holding member;

the second region is provided above the upper surface of the holding member; and

the first region includes a part directly contacted by the substrate to be processed and by contact of the substrate to be processed with the directly contacted part, the partial region in the first region is covered without generating a gap with the substrate to be processed and part of the gap between the holding member and the focus ring is closed."

<The different features>
*Different feature 1: The holding member of the Invention 1 has an "end surface partially including a flat end surface" and the focus ring thereof has an "inner wall surface partially including a flat wall surface facing the flat end surface of the holding member;" whereas the electrostatic chuck of the Cited Invention is "disk-shaped" and the focus ring thereof is "annular-shaped."

*Different feature 2: A gap between the end surface of the holding member and the inner wall surface of the focus ring is specified to be "larger than 0 and equal to or smaller than three times the length (λ_D) of Debye represented by formula (1)" in Invention 1; whereas in the Cited Document, it is specified to be "0.05 to 0.4 mm."

B Judgment
*Regarding Different feature 1
The Cited Invention relates to a substrate processing apparatus which performs a plasma etching process on a circular plate-shaped silicon wafer for semiconductor devices.
On the other hand, according to Cited Documents 2 to 4, the following can be understood: as a wafer for semiconductor devices, a circular plate-shaped wafer is used and a circular plate-shaped wafer having an end surface partially including a flat end surface is also widely used as an orientation flat type wafer; and a substrate processing apparatus for processing a wafer of such a shape has a structure in which the shapes of the holding member for holding the wafer and the ring member provided so as to surround the holding member are made to be those corresponding to the shapes of the wafer; that is, the holding member has an end surface partially including a flat end surface and the ring has an inner wall surface partially including a flat wall surface facing the flat end surface of the holding member.
Accordingly, when the substrate processing apparatus of the Cited Invention is used for plasma processing of a circular plate-shaped wafer having an end surface partially including a flat end surface, a person skilled in the art could have easily conceived of adopting, as an electrostatic chuck for holding the wafer and a focus ring in the Cited Invention, an electrostatic chuck having an end surface partially including a flat end surface so as to make its own shape correspond to that of the wafer and a focus ring having an inner wall surface partially including a flat wall surface facing the flat end surface of the electrostatic chuck; that is, adopting, in the Cited Invention, the configuration of Invention 1 with regard to Different feature 1 by adopting the well-known structures described in Cited Documents 2 to 4.

*Regarding Different feature 2
The Cited Invention is an invention in which a gap (C) between an outer peripheral surface of an upper disk portion of an electrostatic chuck, which has a two-layer structure including the upper disk portion and a lower disk portion having a diameter larger than that of the upper disk portion and in which each thickness of the lower disk portion and the upper disk portion is 1 mm, and an inner peripheral surface

of the focus ring is set in the range from 0.05 mm to 0.4 mm, thereby preventing plasma from entering between the outer peripheral surface of the 1 mm-thick upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring.

In addition, the above specification relating to the size of the gap (C) between the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring is made for the purpose of preventing plasma from entering the gap (C) between the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring; and it can be said that the specification provides such an effect that by preventing plasma from entering the gap (C), it is possible to prevent plasma in performing a plasma process on a wafer from reaching the surface of the metal base and the adhesive layer, to prevent the wear of the adhesive layer and the occurrence of arcing on the surface of the metal base, thereby preventing damage to the surfaces, and further to prevent contamination of the metal and the generation of particles due to arcing ([0055]).

Further, it is described in [0053] of Cited Document 1 that "If the gap (C) exceeds 0.4 mm, the effect of preventing the plasma from entering is reduced. Further, if the gap (C) is smaller than about 0.05 mm, the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring may be in contact with each other, thereby causing damage to the surfaces. If the gap (C) ranges from 0.05 mm to about 0.4 mm, it is possible to prevent the plasma from entering while preventing damage due to contact."

Accordingly, from the above description of Cited Document 1, it can be said that a person skilled in the art can understand that in Cited Invention, the smaller the gap (C) between the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring is made, the larger the effect of preventing plasma from entering is and as a result, the effect can be more surely obtained.

Then, it could have been easily conceived of by a person skilled in the art to set a value of the gap between the end surface of the holding member and the inner wall surface of the focus ring to a smaller value so as to obtain the above effect by surely preventing entry of plasma; and in this case, no significant difficulty is recognized in adopting as the size of the gap (C) a value included in the range satisfying the condition of "equal to or smaller than three times the length (λ_D) of Debye represented by Formula (1)" of Invention 1 also from the fact that the above "equal to or smaller than three times the length (λ_D) of Debye represented by Formula (1)" does not specify its lower limit.

In other words, with regard to Different feature 2, a person skilled in the art could have easily selected a value satisfying the condition of the Invention 1 in the Cited Invention.

C Regarding the effect

The effect obtained by adopting the configuration of the Invention 1 in the Cited Invention with regard to Different features 1 and 2 falls within a scope that can be predicted by a person skilled in the art, and it cannot be recognized to be remarkable.

D Regarding appellant's allegation

The appellant alleges the following in the written opinion submitted on October

12, 2017:

"In addition, also in FIG. 2 and FIG. 3 in the Cited Document 2, a gap B is provided between the wafer W and the focus ring 25," "Further, there is no description of suggesting that such a gap is not to be provided, in Cited Documents 1 and 2."

However, [0052] in Cited Document 1 describes "A gap (B) between the wafer W and the focus ring 25 at the overlapping portion of the wafer W and the focus ring 25 is equal to or smaller than, e.g., 0.4 mm. If the gap is larger than 0.4 mm, the effect of preventing entry of the plasma is insufficient. If the gap between the wafer W and the focus ring 25 is equal to or smaller than 0.4 mm, it is possible to effectively prevent entry of the plasma. In this case, <u>the lower flat surface of the wafer W may be in contact with the upper flat surface of the focus ring 25</u> ...."

In addition, the fact that the wafer W and the focus ring 25 are "in contact with" each other leads to the recognition that the focus ring 25 includes a part directly contacted by the wafer W, and by contact of the wafer with the directly contacted part, the partial region in the focus ring is covered without generating a gap with the wafer.

Therefore, the above appellant's allegation cannot be accepted.

(2) Regarding the inventive step of Claim 2

The corresponding features and different features between Invention 2 and the Cited Invention include the following Different feature 3 in addition to the above corresponding features and Different features 1 and 2:

*Different feature 3: A gap between the end surface of the holding member and the inner wall surface of the focus ring is specified to be "larger than 0 and equal to or smaller than 350 μm" in Invention 2; whereas in the Cited Document, it is specified to be "0.05 to 0.4 mm."

*Regarding Different feature 3

In the Cited Invention, the gap (C) between the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring is set for the purpose of preventing entry of plasma, and it is described that "If the gap (C) exceeds 0.4 mm, the effect of preventing entry of the plasma is reduced. Further, if the gap (C) is smaller than about 0.05 mm, the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring may be in contact with each other, thereby causing damage to the surfaces. If the gap (C) ranges from 0.05 mm to 0.4 mm, it is possible to prevent entry of the plasma while preventing damage due to contact."

Accordingly, it can be understood that in the Cited Invention, the smaller the gap (C) between the outer peripheral surface of the upper disk portion of the electrostatic chuck and the inner peripheral surface of the focus ring is made, the larger the effect of preventing entry of plasma is.

In view of the above, a person skilled in the art could have selected a value included in the range from 0.05 to 0.35 mm which is obtained by lowering the upper-limit value in the range specified in the Cited Invention, as a value of the gap between the end surface of the holding member and the inner wall surface of the focus ring for the purpose of more surely preventing entry of plasma; that is, a value satisfying the condition of the Invention 2 with regard to Different feature 3.

(3) Summary of the judgment

As described above, both Invention 1 and Invention 2 could have been easily made on the basis of the inventions described in Cited Document 1 and Cited Documents 2 to 4.

Therefore, the appellant should not be granted a patent for the Invention in accordance with the provisions of Article 29(2) of the Patent Act.

5 Closing

As described above, the present application should be rejected.

Therefore, the appeal decision shall be made as described in the conclusion.

January 29, 2018

Chief administrative judge:	SUZUKI, Tadaaki
Administrative judge:	KATO, Koichi
Administrative judge:	SUTO, Tatsuya