Abstract: A planar-type ICP (Inductively Coupled Plasma) antenna for generating a high density plasma is capable of improving uniformity of plasma as well as improving density of plasma. For this purpose, the planar-type ICP antenna for generating a high density plasma includes a first antenna spirally shaped outward from an end thereof, a second antenna having an end spaced apart from the end of the first antenna and spirally shaped in the same direction as the first antenna, a bridge member connecting the ends of the first and second antennas and having a center portion bent to be protruded upward, and a connection member mounted above the first and second antennas and the bridge member to connect the other end of the first antenna to the other end of the second antenna. A high frequency power is connected to the connection member, and the bridge member is grounded using a ground wire.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Description

PLANAR-TYPE ICP ANTENNA FOR GENERATING HIGH DENSITY PLASMA

Technical Field

[1] The present invention relates to a planar-type ICP (Inductively Coupled Plasma) antenna for generating a high-density plasma, and more particularly to an ICP antenna capable of improving uniformity of plasma together with increasing a density of plasma.

Background Art

[2] Generally, plasma generators are classified into an ICP (Inductive Coupled Plasma) generator, a CCP (Capacitively Coupled Plasma) generator, a microwave plasma generator and so on. Among them, the ICP generator is widely used since it may generate a high-density plasma under a low operation pressure. The ICP generator includes a chamber 11, a gas injection unit (not shown) for injecting a reaction gas into the chamber 11, a vacuum pump 13 for making the chamber 11 vacuous before the reaction gas is injected thereto, an antenna 15 mounted to an upper portion of dielectric substance, a power supply 17 for supplying power to the antenna 15, and a chuck 19 to which a substrate 20 to be processed is mounted, as shown in FIG. 1.

[3] The antenna 15 is spirally shaped as shown in FIG. 2, and it is connected to the power source at its center point, which is an end 15a thereof, and grounded at the other end 15b.

[4] If power is supplied to the antenna 15, a magnetic field changing along with time is formed in a direction perpendicular to the plane formed by the antenna 15, and this magnetic field forms an inductive electric field in the chamber 11. This inductive electric field heats electrons to generate a plasma inductively coupled with the antenna 15. This plasma is used for etching or deposition of a substrate. Meanwhile, if a separate power 18 is applied to the chuck 19, it is possible to control the energy of plasma input to the substrate 20. Reference numerals 17a and 18a respectively designate impedance matching circuits, and reference numeral 10 designates an ICP generator.

[5] However, as a plasma density in a portion 15a of the antenna 15 to which power is applied, namely in a center portion, is lowered, a plasma density in an outer region is increased, and an electron temperature is high in the center portion and lowered in the outer region. Since the electron temperature is high in the center portion, the plasma in the center portion is scattered out. In addition, since a temperature of the glass surface in the outer region is high, an etching rate by plasma is faster in the outer region than
in the center portion.

In order to solve the above problems, it is required to increase density and temperature of plasma as a whole and also improve uniformity of plasma and uniformity of electron temperature in the center portion and the outer region.

Disclosure of Invention

Technical Problem

A planar-type ICP (Inductively Coupled Plasma) antenna for generating a high density plasma according to the present invention is designed to solve the problems of the prior art, and therefore it is an object of the present invention to provide a planar-type ICP antenna capable of improving uniformity of plasma and uniformity of electron temperature in a center portion and an outer region thereof.

Technical Solution

In order to accomplish the above object, the present invention provides a planar-type ICP (Inductively Coupled Plasma) antenna for generating a high density plasma, which includes a first antenna spirally shaped outward from an end thereof; a second antenna having an end spaced apart from the end of the first antenna by a predetermined distance and spirally shaped in the same direction as the first antenna; a bridge member for interconnecting the ends of the first and second antennas, the bridge member having a center portion bent to protrude upward; and a connection member installed above the first and second antennas and the bridge member to connect the other end of the first antenna and the other end of the second antenna, wherein a high frequency power is connected to the connection member, and the bridge member is grounded using a ground wire.

In another aspect of the present invention, there is also provided a planar-type ICP antenna for generating a high density plasma, which includes a first antenna spirally shaped outward from an end thereof; a second antenna having an end spaced apart from the end of the first antenna by a predetermined distance and spirally shaped in the same direction as the first antenna; and a connection member installed above the first and second antennas to connect the other end of the first antenna and the other end of the second antenna, wherein a high frequency power is connected to the connection member, and the ends of the first and second antennas are grounded using a ground wire.

Preferably, a capacitor is installed to a predetermined position of the antenna or the ground wire so as to make a voltage applied to the entire antenna uniform and minimize a phase difference of current and voltage.
Here, the ground wire is preferably perpendicular to a plane formed by the first and second antennas, and the ground wire is preferably connected to a ground wire of an impedance matching circuit or a ground wire of a chamber wall.

Brief Description of the Drawings

FIG. 1 is a sectional view showing an ICP (Inductively Coupled Plasma) generator having a conventional ICP antenna;

FIG. 2 is a plane view showing the ICP antenna of FIG. 1;

FIG. 3 is a perspective view showing an ICP antenna according to a preferred embodiment of the present invention;

FIG. 4 is a sectional view showing a plasma generator to which the ICP antenna of FIG. 3 is installed;

FIG. 5 is a perspective view showing an ICP antenna according to another embodiment of the present invention;

FIG. 6 is a sectional view showing a plasma generator to which the ICP antenna of FIG. 5 is installed; and

FIG. 7 is a perspective view showing an ICP antenna according to still another embodiment of the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, preferred embodiments of the present invention will be described in detail referring to the accompanying drawings. Prior to the description, it should be understood that the terms used in the specification and appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present invention on the basis of the principle that the inventor is allowed to define terms appropriately for the best explanation. Therefore, the description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the invention, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the invention.

FIG. 3 is a perspective view showing an ICP (Inductively Coupled Plasma) antenna according to a preferred embodiment of the present invention, and FIG. 4 is a sectional view showing a plasma generator to which the above antenna is installed.

Referring to FIGs. 3 and 4, the antenna 100 includes first and second antennas 40, 50 spirally shaped, a bridge member 60 for interconnecting ends 42, 52 of the first and second antennas 40, 50, and a connection member 70 for connecting the other end 44 of the first antenna 40 to the other end 54 of the second antenna 50. Meanwhile, in
FIG. 4, the same reference numeral as used in FIG. 2 designates the same component having the same function.

[26] The first antenna 40 is spirally bent outward from its end 42. The end 42 of the first antenna 40 is connected to the bridge member 60, and the other end 44 of the first antenna 40 is connected to the connection member 70.

[27] The second antenna 50 is spirally bent outward from its end 52, similarly to the first antenna 40. The end 52 of the second antenna 50 is spaced apart from the end 42 of the first antenna 40 by a predetermined distance. The ends 42, 52 of the first and second antennas 40, 50 are interconnected by means of the bridge member 60. The other end 54 of the second antenna 50 is connected to the connection member 70. The spirals of the first and second antennas 40, 50 are rotated in the same direction. In addition, though it is illustrated in the drawings that the first and second antennas 40, 50 are rotated in a counterclockwise direction, the first and second antennas may also be rotated in a clockwise direction.

[28] The bridge member 60 interconnects the ends 42, 52 of the first and second antennas 40, 50. That is to say, one end 62 of the bridge member 60 is connected to the end 42 of the first antenna 40, and the other end 64 of the bridge member 60 is connected to the end 52 of the second antenna 50. A center portion of the bridge member 60 is bent to protrude upward. Preferably, the bridge member 60 has an inverted U shape.

[29] A ground wire 66 is connected to the bridge member 60. Preferably, two ground wires 66 are connected to the bridge member 60 as shown in FIG. 4.

[30] In addition, the ground wires 66 are connected to a ground wire (not shown) of the impedance matching circuit 17a and a ground wire (not shown) of a wall of the chamber 11, with being perpendicular to the plane formed by the first and second antennas 40, 50.

[31] The connection member 70 interconnects the other end 44 of the first antenna 40 and the other end 54 of the second antenna 50. The connection member 70 is installed to pass above the first and second antennas 40, 50 and the bridge member 60. A high frequency power 17 is connected to the connection member 70. Thus, in the antenna 100, the high frequency power 17 is applied to the other ends 44, 54 of the first and second antennas 40, 50.

[32] FIG. 5 is a perspective view showing an ICP antenna according to another embodiment of the present invention, and FIG. 6 is a sectional view showing a plasma generator to which the above antenna is installed.

[33] Referring to FIGs. 5 and 6, the antenna 100a includes first and second antennas 40, 50 spirally shaped, a connection member 70 for connecting the other end 44 of the first antenna 40 and the other end 54 of the second antenna 50, and a capacitor 80 installed.
to the first and second antennas 40, 50 or the ground wire 66. Meanwhile, in FIG. 6, the same reference numeral as used in FIG. 2 designates the same component having the same function.

34 The first and second antennas 40, 50 and the connection member 70 are identical to the first and second antennas 40, 50 and the connection member 70 of the former embodiment, and they are not described in detail here.

35 The capacitor 80 is installed for allowing the voltage applied to the entire antenna 100a to be uniform, and for minimizing a phase difference of current and voltage. The capacitor 80 is a common one used for condensing electricity. The capacitor 80 is installed to a predetermined position of the first and second antennas 40, 50, or to the ground wire 66.

36 Preferably, the capacitor 80 has a withstanding voltage of about several hundred volts to 15 kV and a withstanding current of several amperes to several hundred amperes in consideration of the intensity of the applied high frequency power 17 and the entire configuration of the antenna 100a.

37 In addition, the condensing ability of the capacitor 80 has a capacity of a several PF to several thousand PF in consideration of size and shape of the antenna 100a.

38 Meanwhile, FIG. 7 is a perspective view showing an ICP antenna according to another embodiment of the present invention. The antenna 100b includes first and second antennas 40b, 50b spirally shaped, a connection member 70b for connecting the other end 44b of the first antenna 40b and the other end 54b of the second antenna 50b, and a capacitor (not shown) installed to the first and second antenna 40b, 50b or the ground wire (not shown).

39 Ends 42b, 52b of the first and second antennas 40b, 50b are grounded using ground wires respectively, and the other ends 44b, 54b of the first and second antennas 40b, 50b are connected to the connection member 70b. A high frequency power (not shown) is applied to the connection member 70b.

40 Industrial Applicability

41 The planar-type ICP antenna for generating a high density plasma according to the present invention gives the following effects. First, ends of the first and second antennas are connected using a bridge member, the bridge member is grounded, and a high frequency power is applied to the other ends of the first and second antennas, thereby capable of increasing density and temperature of the plasma as a whole and improving uniformity of plasma and uniformity of electron temperature in a center portion and an outer region.

42 Second, by installing a capacitor to the first and second antennas or the ground
wire, a voltage applied to the antenna becomes uniform, and a phase difference of current and voltage may be minimized.
Claims

[1] A planar-type ICP (Inductively Coupled Plasma) antenna for generating a high density plasma, comprising:
a first antenna spirally shaped outward from an end thereof;
a second antenna having an end spaced apart from the end of the first antenna by a predetermined distance and spirally shaped in the same direction as the first antenna;
a bridge member for interconnecting the ends of the first and second antennas, the bridge member having a center portion bent to protrude upward; and
a connection member installed above the first and second antennas and the bridge member to connect the other end of the first antenna and the other end of the second antenna,
wherein a high frequency power is connected to the connection member, and the bridge member is grounded using a ground wire.

[2] A planar-type ICP antenna for generating a high density plasma, comprising:
a first antenna spirally shaped outward from an end thereof;
a second antenna having an end spaced apart from the end of the first antenna by a predetermined distance and spirally shaped in the same direction as the first antenna; and
a connection member installed above the first and second antennas to connect the other end of the first antenna and the other end of the second antenna, wherein a high frequency power is connected to the connection member, and the ends of the first and second antennas are grounded using a ground wire.

[3] The planar-type ICP antenna according to claim 2,
wherein a capacitor is installed to a predetermined position of the antenna or the ground wire so as to make a voltage applied to the entire antenna uniform and minimize a phase difference of current and voltage.

[4] The planar-type ICP antenna according to any of claims 1 to 3,
wherein the ground wire is perpendicular to a plane formed by the first and second antennas, and the ground wire is connected to a ground wire of an impedance matching circuit or a ground wire of a chamber wall.
A. CLASSIFICATION OF SUBJECT MATTER

H05H 1/34(2006.01)1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 H05H 1/36 B03C 3/66 H05B 6/66 HOIJ 23/34 H05B 6/68 H02M 3/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

KOREAN PATENTS AND APPLICATIONS FOR INVENTIONS SINCE 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PAJ, FPD, USPAT, eKIPASS, IEEE 'TCP', 'ANTENNA', 'PLASMA', 'DENSITY'

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US2004/0255864 A1 (SAMSUNG ELECTRONICS CO., LTD ) 23 DECEMBER 2004 (2004-12-23) see figure 2, right side of page 1 line 1-line 35</td>
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