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Inventor(s)	Aikawa; Katsuyoshi et al.

Mounting table and substrate processing apparatus

Abstract

There is provided a mounting table. The mounting table comprises: a dielectric plate having a through-hole at an outer peripheral portion thereof and having a substrate support on which a substrate is placed; a support member; a first heat insulating member disposed between the dielectric plate and the support member; a first biasing member disposed between the first heat insulating member and the support member, and a fastening member configured to detachably fix the dielectric plate to the support member by way of penetrating through the through-hole of the dielectric plate, the first heat insulating member, and the first biasing member.

Inventors: **Aikawa; Katsuyoshi (Tokyo, JP), Sone; Hiroshi (Tokyo, JP), Orimoto; Shinji (Yamanashi, JP)**

Applicant: **TOKYO ELECTRON LIMITED** (Tokyo, JP)

Family ID: **1000008767604**

Assignee: **Tokyo Electron Limited (Tokyo, JP)**

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Primary Examiner: Nguyen; Hung D

Attorney, Agent or Firm: Fenwick & West LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application claims priority to Japanese Patent Application No. 2020-206789 filed on Dec. 14, 2020, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

(2) The present disclosure relates to a mounting table and a substrate processing apparatus.

BACKGROUND

(3) A substrate processing apparatus having a mounting table on which a substrate is placed in a chamber is known. Japanese Patent Publication No. 5270310 discloses a substrate processing apparatus in which a susceptor having an electrostatic chuck is disposed in a processing chamber.

SUMMARY

(4) A dielectric plate (electrostatic chuck) of the mounting table disposed in the chamber is replaced during maintenance of the substrate processing apparatus, for example. Therefore, it is required to improve the maintenance of the mounting table.

(5) In one aspect, the present disclosure provides a mounting table whose maintenance is improved

and a substrate processing apparatus.
(6) In accordance with an aspect of the present disclosure, there is provided a mounting table comprising: a dielectric plate having a through-hole at an outer peripheral portion thereof and having a substrate support on which a substrate is placed; a support member; a first heat insulating member disposed between the dielectric plate and the support member; a first biasing member disposed between the first heat insulating member and the support member, and a fastening member configured to detachably fix the dielectric plate to the support member by way of penetrating through the through-hole of the dielectric plate, the first heat insulating member, and the first biasing member.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The objectives and features of the present disclosure will become apparent from the following description of embodiments, given in conjunction with the accompanying drawings, in which:
(2) FIG. **1** is an example of a schematic cross-sectional view of a substrate processing apparatus according to an embodiment;
(3) FIG. **2** is an example of a side view of an electrostatic chuck;
(4) FIG. **3** is an example of a top view of a stage from which the electrostatic chuck is removed;
(5) FIG. **4** is an example of a cross-sectional view of the stage;
(6) FIG. **5** is an example of a partially enlarged cross-sectional perspective view of the stage; and
(7) FIG. **6** is an example of a partially enlarged cross-sectional perspective view of the stage.
DETAILED DESCRIPTION
(8) Hereinafter, embodiments for carrying out the present disclosure will be described with reference to the accompanying drawings. Like reference numerals will be given to like parts having substantially the same configurations throughout this specification and the drawings, and redundant description thereof will be omitted.
(9) A substrate processing apparatus **1** according to an embodiment will be described with reference to FIG. **1**. FIG. **1** is an example of a schematic cross-sectional view of the substrate processing apparatus **1** according to the embodiment. The substrate processing apparatus **1** includes a stage (mounting table) **40**, a power supply **50**, a heat transfer gas supply device **60**, a processing gas supply device **70**, an exhaust device **80**, and a chamber **90**.
(10) The chamber **90** has a lid **91** and a container **92**. The container **92** opens upward. The lid **91** closes the opening of the container **92** to make the chamber **90** airtight. A stage **40** on which a substrate W to be processed is placed is disposed in the chamber **90**. The stage **40** has an electrostatic chuck **10**, a stand **20**, and a water-cooling flange **30**.
(11) The electrostatic chuck **10** attracts and supports the substrate W placed on a substrate support **11** (see FIG. **2** to be described later). The electrostatic chuck **10** is formed of a dielectric plate and is made of ceramic (e.g., alumina or the like). A heater **15** for adjusting a temperature of the substrate support **11** on which the substrate W is placed is disposed in the electrostatic chuck **10**. The heater **15** may be divided into a plurality of zones in a circumferential direction and/or a radial direction of the electrostatic chuck **10**, and the temperatures in the zones can be controlled individually. Further, the electrostatic chuck **10** has an electrode (not shown) for electrostatically attracting the substrate W.
(12) The electrostatic chuck **10** can be attached to and detached from the stand **20**. The stand **20** supports the electrostatic chuck **10**. The water-cooling flange **30** supports the stand **20**. A channel (not shown) through which cooling water circulates is formed in the water-cooling flange **30**. Accordingly, when the substrate processing apparatus **1** performs desired processing on the substrate W, the water-cooling flange **30** has a temperature lower than that of the electrostatic

chuck **10**. The structure of the stage **40** will be described later with reference to FIGS. **2** to **6**.
(13) The power supply **50** supplies a power to the heater **15** of the electrostatic chuck **10**. Further, the substrate processing apparatus **1** includes a power supply (not shown) for supplying a power to an electrode (not shown) for electrostatic attraction in the electrostatic chuck **10**. For example, when a DC voltage is applied to the electrode for electrostatic attraction, the substrate W is attracted and held on the electrostatic chuck **10** by a Coulomb force.
(14) The heat transfer gas supply device **60** supplies a heat transfer gas (e.g., He gas) to a space between the substrate W and the electrostatic chuck **10**. Accordingly, thermal conductivity between the substrate W and the electrostatic chuck **10** is improved.
(15) The processing gas supply device **70** supplies a processing gas into the chamber **90**. The exhaust device **80** exhausts the gas in the chamber **90**.
(16) With the above configuration, in the substrate processing apparatus **1**, the substrate W placed on the stage **40** is attracted on the electrostatic chuck **10**. Then, in the substrate processing apparatus **1**, the heater **15** is controlled to control the temperature of the substrate W. For example, the temperature of the substrate W is controlled such that in-plane uniformity can be ensured. In the substrate processing apparatus **1**, the atmosphere in the chamber **90** is set to a desired vacuum atmosphere using the exhaust device **80**, and a desired processing (e.g., film formation, etching, or the like) is performed on the substrate W placed on the stage (substrate support) **40** by supplying the processing gas from the processing gas supply device **70** into the chamber **90**.
(17) <Stage>
(18) Next, the structure of the stage **40** on which the substrate W is placed will be further described with reference to FIGS. **2** to **6**. FIG. **2** is an example of a side view of the electrostatic chuck **10**. FIG. **3** is an example of a top view of the stage **40** from which the electrostatic chuck **10** is removed. FIG. **4** is an example of a cross-sectional view of the stage **40** taken along a line IV-IV (see FIG. **3**).
(19) As shown in FIG. **2**, the electrostatic chuck **10** has the substrate support **11** on which the substrate W is placed, and an outer peripheral portion **12**. A plurality of through-holes **13** (see FIG. **4**) through which bolts **25** (see FIG. **4**) are inserted are formed in the outer peripheral portion **12** of the electrostatic chuck **10**. The electrostatic chuck **10** is detachably fixed to the stand **20** using the bolts **25**.
(20) A plurality of contact pins **14** stands upright on a back surface side of the electrostatic chuck **10**. The contact pins **14** are connected to the heater **15** disposed in the dielectric plate of the electrostatic chuck **10** or the electrode (not shown) for electrostatic attraction. When the electrostatic chuck **10** is attached to the stand **20**, the contact pins **14** are electrically connected to sockets **285** (see FIGS. **3** and **4**) of the stand **20**.
(21) Further, as shown in FIG. **4**, a nozzle insertion portion **16** into which the nozzle **62** is inserted is formed on the back surface side of the electrostatic chuck **10**. Further, a gas channel **17** extends from the nozzle insertion portion **16** to the substrate support **11** of the electrostatic chuck **10**. When the electrostatic chuck **10** is attached to the stand **20**, the nozzle **62** is inserted into the nozzle insertion portion **16**. Accordingly, the heat transfer gas supplied from the nozzle **62** is supplied from the nozzle insertion portion **16** to the space between the substrate support **11** of the electrostatic chuck **10** and the substrate W (see FIG. **1**) while passing through the gas channel **17**.
(22) The stand (support member) **20** includes a shaft **21**, an annular member **22**, a heat insulating member **23**, and a biasing member **24**.
(23) The shaft **21** has a hollow portion **211** penetrating the center thereof in a vertical direction. Further, the shaft **21** has a flange shape in which an upper side is widened. A cylindrical recessed portion **212** is formed on an upper surface of the shaft **21**. Further, a female screw hole **213** having a diameter smaller than that of the recessed portion **212** is formed on a bottom surface of the recessed portion **212**.
(24) The annular member **22** has an annular portion **221**. Through-holes **222** through which the

bolts **25** (see FIG. **4**) are inserted are formed in the annular portion **221**. Further, a nozzle guide **223** is disposed toward an inner side of the annular portion **221**. The nozzle guide **223** has a hole **224** through which the nozzle **62** is inserted. The hole **224** is formed larger than the nozzle **62**, so that the nozzle **62** can move through the hole **224**.

(25) The heat insulating member **23** is a cylindrical member through which the bolt **25** can be inserted, and is made of, e.g., ceramic or the like.

(26) The biasing member **24** is a member through which the bolt **25** can be inserted and biases the bolt **25** in the axial direction. The biasing member **24** may be, e.g., a spring washer, a disc spring, or the like.

(27) The bolt **25** has a head portion, a shaft portion, and a screw portion.

(28) <Method for Fixing the Electrostatic Chuck **10**>

(29) Next, a method for fixing the electrostatic chuck **10** will be described with reference to FIGS. **4** and **5**. FIG. **5** is an example of a partially enlarged cross-sectional perspective view of the stage **40** taken along a line IV-IV (see FIG. **3**). The biasing member **24** is disposed at the recessed portion **212** of the shaft **21**, and the heat insulating member **23** is disposed thereon. The annular member **22** is disposed on the heat insulating member **23**. The electrostatic chuck **10** is disposed on the annular member **22**. The bolts **25** penetrate through the through-holes **13** of the electrostatic chuck **10**, the through-holes **222** of the annular member **22**, the heat insulating member **23**, and the biasing member **24**. The electrostatic chuck **10** can be fixed to the stand **20** by screwing the screw portion of the bolt **25** into the female screw hole **213**.

(30) When the substrate W is processed, the electrostatic chuck **10** is heated by the heater **15**. On the other hand, the shaft **21** is fixed to the water-cooling flange **30**. In the stage **40** of the present embodiment, the electrostatic chuck **10** is fixed to the shaft **21** via the heat insulating member **23**, so that heat leakage from the electrostatic chuck **10** to the shaft **21** can be suppressed. Accordingly, the temperature uniformity of the substrate support **11** of the electrostatic chuck **10** can be improved.

(31) Further, the inner diameters of the through-hole **13** of the electrostatic chuck **10** and the through-hole **222** of the annular member **22** are formed greater than the outer diameter of the shaft portion of the bolt **25**. Therefore, even if there is a difference in thermal expansion of the electrostatic chuck **10**, the annular member **22**, and the shaft **21**, sliding occurs at the interface thereof and, thus, the generation of thermal stress can be suppressed.

(32) Since the biasing member **24** can be disposed between the heat insulating member **23** and the shaft **21** having a temperature lower than that of the electrostatic chuck **10**, the biasing member **24** having low heat resistance can also be used. In other words, various materials can be selected for the biasing member **24**.

(33) <Method for Connecting the Heat Transfer Gas Nozzle **62**>

(34) Next, a method for fixing the electrostatic chuck **10** will be described with reference to FIGS. **2** to **5**. The nozzle **62** is connected to the heat transfer gas supply device **60** (see FIG. **1**) through a heat transfer gas supply line **61**.

(35) A cylindrical recessed portion **214** is formed on the upper surface of the shaft **21**. Further, a hole **215** having a diameter smaller than that of the recessed portion **214** is formed on the bottom surface of the recessed portion **214**. A biasing member **27** is disposed at the recessed portion **214** of the shaft **21**, and a heat insulating member **26** is disposed on the biasing member **27**. The nozzle **62** is disposed on the heat insulating member **26**. The horizontal movement of the nozzle **62** is guided by the hole **224** of the nozzle guide **223**.

(36) When the electrostatic chuck **10** is fixed to the shaft **21**, the nozzle **62** is guided by the nozzle guide **223** and, thus, the nozzle **62** can be easily inserted into the nozzle insertion portion **16** of the electrostatic chuck **10**. Then, by fixing the electrostatic chuck **10** to the shaft **21** using the bolts **25**, the nozzle **62** can be press-fitted into the nozzle insertion portion **16**. In addition, a sealing member (not shown) may be disposed between the nozzle **62** and the nozzle insertion portion **16**.

(37) In the stage **40** of the present embodiment, the nozzle **62** is supported by the shaft **21** via the heat insulating member **26**, so that heat leakage from the electrostatic chuck **10** to the shaft **21** can be suppressed. Accordingly, the temperature uniformity of the substrate supporting portion **11** of the electrostatic chuck **10** can be improved.
(38) Since the biasing member **27** can be disposed between the heat insulating member **26** and the shaft **21** having a temperature lower than that of the electrostatic chuck **10**, the biasing member **27** having low heat resistance can also be used. In other words, various materials can be selected for the biasing member **27**.
(39) <Method for Connecting the Contact Pins **14**>
(40) Next, a method for connecting the contact pins **14** will be described with reference to FIGS. **2** to **4** and **6**. FIG. **6** is an example of a partially enlarged cross-sectional perspective view of the stage **40** taken along a line VI-VI (see FIG. **3**). The hollow portion **211** of the shaft **21** is provided with a contact **28** that stands upright from the water-cooling flange **30**.
(41) The contact **28** has a columnar member **281**, a lower plate member **282**, an upper plate member **283**, a tubular member **284**, a socket **285**, a stranded wire **286**, and a connector **287**. The columnar member **281** stands upright from the water-cooling flange **30** and supports the lower plate member **282** and the upper plate member **283**. A recessed portion **282***a* is formed at the lower plate member **282**. A bottom surface of the recessed portion **282***a* is penetrated. A through-hole **283***a* is formed in the upper plate member **283**.
(42) The socket **285** has a shaft portion **285***a*, a flange portion **285***b*, and a terminal **285***c*. The inner diameter of the recessed portion **282***a* is formed greater than the outer diameter of the flange portion **285***b*, and the inner diameter of the through-hole **283***a* is formed greater than the outer diameter of the shaft portion **285***a*. Therefore, the socket **285** can be moved in the horizontal direction. On the other hand, the outer diameter of the flange portion **285***b* is formed greater than the inner diameter of the through-hole **283***a*, so that the movement of the socket **285** in the vertical direction is restricted.
(43) The tubular member **284** is disposed between the lower plate member **282** and the water-cooling flange **30**. The connector **287** is disposed below the tubular member **284**. An electrode pin **288** is connected to the connector **287**. The terminal **285***c* and the connector **287** are connected by the flexible stranded wire **286**.
(44) In accordance with the stage **40**, the electrostatic chuck **10** can be easily removed from the stand **20** (shaft **21**) by removing the bolts **25**. Further, the connection of the heat transfer gas path (the fitting of the nozzle insertion portion **16** and the nozzle **62**) and the connection of the electrical path (the connection between the contact pins **14** and the sockets **285**) can be easily released. Further, when the electrostatic chuck **10** is attached to the stand **20** (the shaft **21**), it can be easily attached by fastening with the bolts **25**. Further, the connection of the heat transfer gas path (the fitting of the nozzle insertion portion **16** and the nozzle **62**) and the connection of the electrical path (the connection between the contact pins **14** and the sockets **285**) can be easily realized.
(45) In the case of replacing the electrostatic chuck **10** from the stage **40** in the chamber **90**, by removing the lid **91** of the chamber **90**, it is possible to attach/detach the bolts **25** and the electrostatic chuck **10** by an operation from the upper opening of the container **92**. Accordingly, the operation during the maintenance of the electrostatic chuck **10** is improved. Further, in the case of replacing the electrostatic chuck **10**, an operation from the side or the bottom of the chamber **90** is not required, so that the operation space can be reduced.
(46) Further, even if the stage **40** thermally expands and there is a difference in thermal expansion of the components, sliding occurs at the interface between the electrostatic chuck **10** and the annular member **22** and at the interface between the annular member **22** and the heat insulating member **23**. Accordingly, the generation of thermal stress can be suppressed.
(47) Further, the socket **285** is supported to be movable in the horizontal direction, and the terminal **285***c* of the socket **285** and the connector **287** are connected by the stranded wire **286**. Thus, the

misalignment of the contact pin **14** can be mitigated. Accordingly, when the contact pin **14** is inserted into the socket **285**, it is possible to suppress load applied to the electrostatic chuck **10**.
(48) Although the mounting table and the substrate processing apparatus according to the embodiments of the present disclosure have been described, the mounting table and the substrate processing apparatus of the present disclosure are not limited to those in the above-described embodiments, and various modifications and improvements can be made within the scope of the present disclosure. The above-described embodiments can be combined without contradicting processing contents thereof
(49) The substrate processing apparatus of the present disclosure may be a plasma processing apparatus that generates plasma in the processing space and processes the substrate. The plasma processing apparatus can be applied to any type of apparatus using capacitively coupled plasma (CCP), inductively coupled plasma (ICP), a radial line slot antenna, electron cyclotron resonance (ECR) plasma, and helicon wave plasma (HWP).
(50) While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the disclosures. Indeed, the embodiments described herein may be embodied in a variety of other forms. Furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the disclosures. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the disclosures.

Claims

1. A mounting table comprising: a dielectric plate having a first through-hole at an outer peripheral portion thereof and having a substrate support on which a substrate is placed; a shaft; a first heat insulating member disposed between the dielectric plate and the shaft; a first biasing member disposed between the first heat insulating member and the shaft, the first heat insulating member being disposed on the first biasing member; and a fastening member configured to detachably fix the dielectric plate to the shaft by way of penetrating through the first through-hole of the dielectric plate, the first heat insulating member, and the first biasing member, wherein the shaft has a first recessed portion formed on an upper surface of the shaft, and the first biasing member and a lower end of the first heat insulating member are disposed at the first recessed portion.
2. The mounting table of claim 1, wherein an inner diameter of the first through-hole of the dielectric plate is greater than the outer diameter of the fastening member inserted into the first through-hole.
3. The mounting table of claim 1, further comprising: an annular member disposed between the dielectric plate and the first heat insulating member and having a second through-hole through which the fastening member is inserted.
4. The mounting table of claim 3, wherein the dielectric plate has a gas channel through which a heat transfer gas circulates, and the annular member has a guide configured to guide a nozzle of the heat transfer gas to the gas channel.
5. The mounting table of claim 4, further comprising: a second heat insulating member disposed between the nozzle and the shaft; and a second biasing member disposed between the second heat insulating member and the shaft; wherein the shaft has a second recessed portion, and the second biasing member and a lower end of the second heat insulating member are disposed at the second recessed portion.
6. The mounting table of claim 1, wherein the dielectric plate has a contact pin, and a connector connected to the contact pin is supported to be movable in a horizontal direction.
7. A substrate processing apparatus comprising: a mounting table comprising: a dielectric plate having a first through-hole at an outer peripheral portion thereof and having a substrate support on

which a substrate is placed, a shaft, a first heat insulating member disposed between the dielectric plate and the shaft, a first biasing member disposed between the first heat insulating member and the shaft, the first heat insulating member being disposed on the first biasing member, and a fastening member configured to detachably fix the dielectric plate to the shaft by way of penetrating through the first through-hole of the dielectric plate, the first heat insulating member, and the first biasing member; and a chamber accommodating the mounting table, wherein the shaft has a first recessed portion formed on an upper surface of the shaft, and the first biasing member and a lower end of the first heat insulating member are disposed at the first recessed portion.
8. The substrate processing apparatus of claim 7, wherein the chamber includes a container having an opening at an upper portion thereof and a lid that closes the opening of the container.