In the electrostatic chuck member described above, a configuration may be adopted in which the electrostatic chuck member further includes at least one of a first insulating bonding layer disposed between the first plate body and the second plate body at a position different from a position of the first electrode layer and a second insulating bonding layer disposed between the second plate body and the third plate body at a position different from positions of the second electrode layer and the power feeding portion bonding layer, and the first insulating bonding layer and the second insulating bonding layer are made of different materials from the first plate body, the second plate body, and the third plate body.

[0010]

In the electrostatic chuck member described above, an outer peripheral surface of the first power feeding portion and the second plate body may be densely bonded at a boundary therebetween, and an outer peripheral surface of the second power feeding portion and the third plate body may be densely bonded at a boundary therebetween.

In the electrostatic chuck member described above, the first plate body, the second plate body, the third plate body, the first power feeding portion, the second power feeding portion, and the first electrode layer, and the power feeding portion bonding layer may be a composite sintered body of an insulating material and a conductive material.

The first plate body, the second plate body, and the third plate body may be a plate body obtained by forming and sintering a mixed powder of aluminum oxide powder and silicon carbide powder.

In the electrostatic chuck member described above, the first power feeding portion and the second power feeding portion may be a columnar member obtained by forming and sintering a mixed powder of aluminum oxide powder and molybdenum carbide powder.

In the electrostatic chuck member described above, the power feeding portion bonding layer may be a layer obtained by disposing and drying a power feeding portion bonding layer paste

body 11. As a result, it is possible to increase the bonding strength between the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33, and the base body 10.

[0074]

In addition, examples of the conductive material contained in the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 are the same as the examples of the conductive material contained in the first electrode layer 13, the second electrode layer 14, and the power feeding portion bonding layer 15. That is, the conductive material contained in the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 is preferably at least one selected from the group consisting of molybdenum carbide (Mo_2C), molybdenum (Mo), tungsten carbide (WC), tungsten (W), tantalum carbide (TaC), niobium carbide (NbC), niobium (Nb), ruthenium (Ru), tantalum (Ta), silicon carbide (SiC), carbon black, carbon nanotubes, and carbon nanofibers.

[0075]

A ratio (compounding ratio) of the content of the insulating material to the content of the conductive material in the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 is appropriately adjusted according to the application. The content of the conductive material in the ratio of the content of the insulating material to the content of the conductive material in the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 is preferably 20% by volume or more and 80% by volume or less, more preferably 23% by volume or more and 60% by volume or less, and still more preferably 25% by volume or more and 50% by volume or less. The ratio may be 30% by volume or more and 45% by volume or less, 33% by volume or more and 40% by volume or less, or the like. By setting the content of the conductive material to 20% by volume or more, the first electrode layer 13, the second electrode layer 14, and the power feeding portion bonding layer 15

the periphery of the power feeding portion 30 is bonded between the power feeding portion 30 and the plate body 11. More specifically, with the ultrasonic flaw detector, measurement is performed by setting an oscillation (ultrasound) frequency to 50 MHz and a focal length to 40 mm, and aligning a focus with a lower surface of the power feeding portion 30 in water. Further, it is determined whether a region in which reflected waves caused by the gap between the power feeding portion 30 and the plate body 11 are confirmed in a range of 1 mm from the outer periphery of the power feeding portion 30 is 50% or less of the entire circumference around the power feeding portion 30. In a case where the region in which the reflected waves are confirmed is 50% or less of the entire circumference, it is determined that "the outer peripheral surface of the power feeding portion 30 and the plate body 11 are densely bonded".

Under the measurement conditions described above using the ultrasonic flaw detector, the region in which the reflected waves caused by the gap between the power feeding portion 30 and the plate body 11 can be confirmed in a range of 1 mm from the outer periphery of the power feeding portion 30 is more preferably 30% or less of the entire circumference, and still more preferably 10% or less of the entire circumference. In a case where the region in which the reflected waves are confirmed is 10% or less of the entire circumference, it can be determined that the outer peripheral surface of the power feeding portion 30 and the plate body 11 are more densely bonded.

[0080]

It is preferable that the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 are prepared in advance as a composite sintered body (calcinated), are inserted into the holes provided in the respective plate bodies 11a, 11b, and 11c, and are bonded by sintering under pressure. By bonding the power feeding portion 30 and the plate body 11 through sintering under pressure, the irregularities on the side surface of the power feeding portion 30 can be eliminated, and since the electric current distribution when the electric

It is preferable that 50% or more of an area of the power feeding portion 30 is bonded to the terminal member 35 using a brazing agent, it is more preferable that 65% or more of the area of the power feeding portion 30 is bonded to the terminal member 35 by the brazing agent, and it is still more preferable that 80% or more of the area of the power feeding portion 30 is bonded to the terminal member 35 by the brazing agent. Whether or not 50% or more of an area of the power feeding portion 30 is bonded to the terminal member 35 by the brazing agent is confirmed by an ultrasonic flaw detector, and can be confirmed with the ultrasonic flaw detector by performing measurement by setting an oscillation (ultrasound) frequency to 50 MHz and a focal length to 40 mm, and aligning a focus with a lower surface of the terminal member 35 in water. In the measurement, a region in which reflected waves caused by the gap are not confirmed on the lower surface of the power feeding portion 30 can be determined as a region in which 50% or more of the area of the terminal member 35 is bonded to the power feeding portion 30. In a case where 50% or more of the area of the power feeding portion 30 is bonded to the terminal member 35 by the brazing agent, the bonding strength of the terminal member 35 can be increased, and the electrical resistance between the terminal member 35 and the power feeding portion 30 can be reduced.

[0099]

As described above, the depth of the recess 33a is equal to or lower than 1/2 of the plate thickness of the third plate body 11c. Therefore, the brazed portion 5 is located on the lower surface 10t side with respect to the halfway position between the lower surface 10t of the base body 10 and the second electrode layer 14. According to the present embodiment, by making the depth of the recess 33a sufficiently shallow, a decrease in heat capacity of the electrostatic chuck member 2 in the vicinity of the brazed portion 5 or deterioration in the heat transfer can be suppressed. As a result, it is possible to improve the temperature uniformity of the electrostatic chuck member 2.

recess 111g is equal to or less than 1/2 of a plate thickness of a third plate body 111c. Therefore, a bottom surface 111f of the recess 111g is located on the lower surface 110t side with respect to a halfway position between the lower surface 110t of the base body 110 and the second electrode layer 14.

[0110]

The third power feeding portion 133 is exposed on the bottom surface 111f of the recess 111g. A lower end surface 133t of the third power feeding portion 133 is disposed at the center of the bottom surface 111f. The terminal member 135 according to the present modification example has a cylindrical shape. An outer diameter of the terminal member 135 is smaller than an inner diameter of the recess 111g. An upper end portion of the terminal member 135 is disposed inside the recess 111g as viewed in the thickness direction. The outer diameter of the terminal member 135 is smaller than an outer diameter of the third power feeding portion 133. A thickness of the third power feeding portion 133 is smaller than the plate thickness of the third plate body 111c. In plan view, the inner diameter of the recess 111g is larger than the outer diameter of the third power feeding portion 133.

[0111]

The upper end portion of the terminal member 135 and the lower end surface 133t of the third power feeding portion 133 are connected by brazing to form a brazed portion 105. The brazed portion 105 is disposed inside the recess 111g.

[0112]

As described above, the depth of the recess 111g is equal to or less than 1/2 of the plate thickness of the third plate body 111c. Therefore, the brazed portion 105 is located on the lower surface 110t side with respect to the halfway position between the lower surface 110t of the base body 110 and the second electrode layer 14. According to the present modification example, by making the depth of the recess 111g sufficiently shallow, a decrease in heat capacity of an

electrostatic chuck member 102 in the vicinity of the brazed portion 105 can be suppressed. As a result, it is possible to improve the temperature uniformity of the electrostatic chuck member 102.

[0113]

In the present modification example, the outer diameter of the terminal member 135 can be made substantially the same as the outer diameter of the power feeding portion 133 or larger than the outer diameter of the power feeding portion 133. By making the outer diameter of the terminal member 135 substantially the same as the outer diameter of the power feeding portion 133 or larger than the outer diameter of the power feeding portion 133, an electric current distribution on a lower surface of the power feeding portion 133 can be made uniform, and deterioration of the temperature uniformity due to the heat generation of the power feeding portion 133 can be prevented. In addition, the bonding strength between the power feeding portion 133 and the terminal member 135 can be increased by increasing the outer diameter of the brazed portion 105.

[0114]

In addition, in the present modification example, the brazed portion 105 may be located on a boundary between the terminal member 135 and the plate body 11, but the outer peripheral surface 32d and the base body 110 are densely bonded at a boundary therebetween, so that an increase in electrical resistance due to the brazing can be suppressed.

[0115]

According to the present modification example, since the brazed portion 105 is disposed inside the recess 111g, the brazed portion 105 does not protrude downward with respect to the lower surface 110t of the base body 110. In addition, the application of a load to the brazed portion 105 in an assembling process can be suppressed. Therefore, the interference between an upper surface of the base member 3 disposed on the lower side of the base body 110 and the brazed

portion 105 can be suppressed. In addition, the discharge between the brazed portion 105 and the base member 3 can be suppressed.

[0116]

<Modification Example 2 of Connection Structure between Power Feeding Portion and Terminal Member>

FIG. 4 is a schematic cross-sectional view of a connection portion between a third power feeding portion 233 and a terminal member 235 according to Modification Example 2, which can be adopted in the above-described embodiment. The connection portion of the present modification example is different from the modification example 1 in that a recess is not provided in a lower surface 210t of a base body 210.

Constituent elements having the same configuration as the constituent elements of the above-described embodiment are denoted by the same reference numerals, and the description thereof is omitted. In addition, the configuration of the present modification example may be adopted in the connecting portion between the second power feeding portion 32 and the terminal member 235 in the above-described embodiment. Unless otherwise specified, preferred numerical values and conditions such as the size in the example described above may be used in the present modification example 2.

[0117]

In the present modification example, the third power feeding portion 233 is exposed on the lower surface 210t of the base body 210. An upper end portion of the terminal member 235 and the lower end surface 233t of the third power feeding portion 233 are connected by brazing to form a brazed portion 205. A thickness of the third power feeding portion 233 is the same as the plate thickness of the third plate body. Therefore, the brazed portion 205 according to the present modification example is located on the lower surface 210t side with respect to a halfway position between the lower surface 210t of the base body 210 and the second electrode layer 14.

According to the present modification example, since neither the lower surface of the base body 210 nor a lower surface of the third power feeding portion 233 is provided with a recess, a decrease in heat capacity of an electrostatic chuck member 202 in the vicinity of the brazed portion 205 can be suppressed. As a result, it is possible to improve the temperature uniformity of the electrostatic chuck member 202.

[0118]

<Manufacturing Method of Electrostatic Chuck Member>

Next, an example of a manufacturing method of the electrostatic chuck member 2 according to the present embodiment will be described with reference to FIG. 1 and the like. The manufacturing method of the electrostatic chuck member 2 according to the present embodiment preferably includes a plate body sintering step, a power feeding portion sintering step, a machining step, a printing step (preferably, a screen printing step), a bonding and sintering step, and a brazing step.

[0119]

The plate body sintering step and the power feeding portion sintering step may be performed in any order, or may be performed simultaneously. The machining step is performed after the plate body sintering step and the power feeding portion sintering step. The printing step, preferably the screen printing step, is performed after the machining step. The bonding and sintering step is performed after the screen printing step or the like. The brazing step is performed after the bonding and sintering step.

[0120]

In the following description, it is assumed that the forming materials of the first plate body 11a, the second plate body 11b, and the third plate body 11c are aluminum oxide-silicon carbide (Al_2O_3-SiC) composite sintered bodies, the first insulating bonding layer 16d and the second insulating bonding layer 16e are aluminum oxide sintered bodies, and the forming

materials of the first electrode layer 13, the second electrode layer 14, the power feeding portion bonding layer 15, the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 are aluminum oxide-tantalum carbide (Al_2O_3-TaC) composite sintered bodies.

[0121]

(Plate Body Sintering Step)

The plate body sintering step is a step of obtaining ceramic plates serving as the first plate body 11a, the second plate body 11b, and the third plate body 11c by sintering. In the plate body sintering step, first, a mixed powder containing silicon carbide powder and aluminum oxide powder is formed into a disk shape to form a formed body (unsintered). Thereafter, using a hot press device, the formed body is sintered at a pressure of 1 MPa to 50 MPa, for example, at a temperature of 1500°C to 2000°C, in a non-oxidative atmosphere, preferably in an inert atmosphere, for a predetermined time while being pressurized, thereby obtaining composite sintered bodies serving as the first plate body 11a, the second plate body 11b, and the third plate body 11c.

[0122]

(Power Feeding Portion Sintering Step)

The power feeding portion sintering step is a step of obtaining conductive sintered bodies serving as the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 by sintering. In the power feeding portion sintering step, first, a mixed powder containing aluminum oxide powder and tantalum carbide is formed into a desired shape such as a disk shape or a column shape to form a formed body (unsintered). Thereafter, using a hot press device, the formed body is sintered at a pressure of 1 MPa to 50 MPa, for example, at a temperature of 1500°C to 2000°C, in a non-oxidative atmosphere, preferably in an inert atmosphere, for a predetermined time while being pressurized, thereby obtaining composite

conductive sintered bodies serving as the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33.

[0123]

(Machining Step)

The machining step preferably includes a disk machining procedure of machining the composite sintered bodies serving as the first plate body 11a, the second plate body 11b, and the third plate body 11c into a disk shape having a desired shape and condition, a perforation procedure of providing the first through-hole 12a in the obtained second plate body 11b and providing the second through-hole 12b and the third through-hole 12c in the obtained third plate body 11c, and a power feeding portion machining procedure of machining the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 into a desired shape and condition.

[0124]

The disk machining procedure and the power feeding portion machining procedure are procedures of machining the sintered bodies into a desired shape or state such as a disk shape or a cylindrical shape by using a machining device for general ceramics, such as a machining device using diamond abrasive grains or the like or a laser machining device.

[0125]

The perforation procedure is performed after the disk machining procedure. The perforation procedure is a procedure of forming the first through-hole 12a, the second through-hole 12b, and the third through-hole 12c by hole drilling machining using a diamond drill, a laser machining method, a discharge machining method, an ultrasonic machining method, or the like.

[0126]

In the machining step, it is preferable that a boundary between the first through-hole 12a and the first power feeding portion 31, a boundary between the second through-hole 12b and the

second power feeding portion 32, and a boundary between the third through-hole 12c and the third power feeding portion 33 are provided with intervals such that diameters of the through-holes are values larger than outer diameters of the power feeding portions by 0.03 mm or more and less than 0.1 mm.

[0127]

By setting the diameters of the through-holes 12a, 12b, and 12c after the machining step (for example, before the screen printing step) to values larger than the outer diameter of the power feeding portion 30 after the machining step by 0.03 mm or more, the plate body 11 and the power feeding portion 30 can be prevented from being damaged when performing pressurization in the bonding and sintering step described below.

[0128]

In addition, by setting the diameters of the through-holes 12a, 12b, and 12c after the machining step to be values larger than the outer diameter of the power feeding portion 30 after the machining step by less than 0.1 mm, the through-holes 12a, 12b, and 12c and the power feeding portion 30 after the bonding and sintering step can be densely bonded at the boundaries therebetween. As a result, it is easy to set a region in which reflected waves around the power feeding portion 30 are confirmed in an ultrasonic flaw detection test at the boundaries between the through-holes 12a, 12b, and 12c and the power feeding portion 30 to 50% or less.

[0129]

A difference between the diameters of the through-holes 12a, 12b, and 12c and the outer diameter of the power feeding portion 30 after the machining step differs in optimal value depending on the outer diameter or the thickness of the power feeding portion 30, the conditions of the printing step and the bonding and sintering step, the accuracy of the machining device used, and the like. Therefore, the values need only be appropriately selected such that the region in which the reflected waves around the power feeding portion 30 are confirmed in the ultrasonic

flaw detection test at the boundaries between the through-holes 12a, 12b, and 12c and the power feeding portion 30 after the bonding and sintering step to 50% or less of the entire circumference.

After the machining step, a disposition step of placing the first power feeding portion 31, the second power feeding portion 32, and the third power feeding portion 33 in the first through-hole 12a, the second through-hole 12b, and the third through-hole 12c may be provided. The disposition step may be performed after the following printing step.

[0130]

(Printing Step, preferably Screen Printing Step)

The printing step, preferably the screen printing step is a step of forming the electrode layer (before sintering), the insulating layer (before sintering), and the power feeding portion bonding layer (before sintering) by applying an insulating layer paste 16dA or 16eA for forming the insulating bonding layer 16 or conductive layer pastes (electrode layer pastes 13A and 14A and power feeding portion bonding layer paste 15A) for forming the electrode layers 13 and 14 and the power feeding portion bonding layer 15 to a desired position of the second plate body 11b or the third plate body 11c by printing, preferably screen printing, to form a layer, and then drying and volatilizing a solvent contained in the paste (see FIG. 5). The insulating layer pastes 16dA and 16eA are made of raw material powders and a solvent of the insulating layer, and are subjected to the bonding and sintering step to form the insulating bonding layer 16 (after sintering). The conductive layer pastes 13A, 14A, and 15A are made of raw material powders and a solvent of the electrode layers 13 and 14 and the power feeding portion bonding layer 15, and are subjected to a bonding and sintering step to form the electrode layers 13 and 14 or the power feeding portion bonding layer 15 (after sintering). Hereinafter, a case where the same paste (conductive layer pastes 13A, 14A, and 15A) is used for the electrode layer pastes 13A, 14A, and 15A and the power feeding portion bonding layer paste 15A will be described. However, different materials may be

used for the electrode layer pastes 13A and 14A and the power feeding portion bonding layer paste 15A.

[0131]

The solvent used for the paste can be optionally selected, and it is preferable to use a solvent having a boiling point of about 150°C to 250°C and having a small amount of residue after drying. A dispersing agent such as a silane coupling agent or a surfactant may be added to the paste in order to improve dispersibility of the powder, a binder or the like may be added to the paste used for screen printing or the like after drying the paste so that the powder does not scatter, or a commercially available solvent for screen printing or the like may be used.

[0132]

The insulating layer pastes 16dA and 16eA serving as the first insulating bonding layer 16d and the conductive layer pastes 13A, 14A, and 15A serving as the first electrode layer 13 are printed by screen printing or the like on a surface on the first plate body 11a side of the second plate body 11b in which the first power feeding portion 31 is inserted into the first through-hole 12a, and applied in a desired shape and thickness. It is preferable that the insulating layer pastes 16dA and 16eA and the conductive layer pastes 13A, 14A, and 15A are applied so as not to contact each other.

The drying after the screen printing or the like need only be performed at a temperature at which the solvent is volatilized, and is preferably performed in a vacuum at a temperature of, for example, 100°C to 300°C.

[0133]

A thickness of the applied insulating layer pastes 16dA and 16eA and conductive layer pastes 13A, 14A, and 15A after drying is preferably 5 μm or more and 500 μm or less, and more preferably 10 μm or more and 250 μm or less. By setting the thickness to 5 μm or more, the bonding strength between the plate bodies 11 can be ensured, and the resistance of the electrode

layers 13 and 14 and the power feeding portion bonding layer 15 can be reduced. On the other hand, in a case where the thickness is more than 500 μm, the number of insulating layers exposed to an outer peripheral portion of the base body 10 increases, which may reduce the plasma resistance of the base body 10, so that it is preferable to set the thickness to 500 μm or less.

[0134]

In addition, the conductive layer pastes 13A, 14A, and 15A after drying may be made thicker than the insulating layer pastes 16dA and 16eA after drying. By making the conductive layer pastes 13A, 14A, and 15A after drying thicker than the insulating layer pastes 16dA and 16eA after drying, the conduction between the electrode layers 13 and 14, the power feeding portion bonding layer 15, and the power feeding portion 30 can be reliably ensured. However, even in a case where the conductive layer pastes 13A, 14A, and 15A after drying are thinner than the insulating layer pastes 16dA and 16eA after drying, relatively good conduction can be ensured as long as the thicknesses are similar to each other. In addition, in a case where the thicknesses of the conductive layer pastes 13A, 14A, and 15A after drying are made too thicker, a gap is likely to be generated at the boundary between the insulating bonding layer 16 and the plate body 11, and the withstand voltage of the base body 10 may be decreased. In addition, in the present embodiment, the thicknesses of the conductive layer pastes 13A, 14A, and 15A after drying are preferably 90% or more and 120% or less, more preferably 95% or more and 110% or less, and still more preferably 100% or more and 110% or less, with respect to the thicknesses of the insulating layer pastes 16dA and 16eA after drying.

[0135]

A formed body density (density of the formed body (unsintered)) of each paste after drying is considered. The formed body density after drying is a ratio of the density to the density after complete densification densified by sintering, and is expressed in percentage. The formed

body density of the paste after drying can be obtained by using the thickness and weight of the paste after drying.

Here, the formed body density of the conductive layer pastes 13A, 14A, and 15A after drying is referred to as a first formed body density P13. In addition, the formed body density of the insulating layer pastes 16dA and 16eA after drying is referred to as a second formed body density P16.

[0136]

In the present embodiment, it is preferable that the first formed body density P13 is a value equal to or lower than the second formed body density P16 (P13 ≤ P16). Further, a difference between the first formed body density P13 and the second formed body density P16 is preferably 0% or more and 20% or less (0% ≤ P16 - P13 ≤ 20%), and more preferably 0.5% or more and 10% or less (0.5% ≤ P16 - P13 ≤ 10%).

[0137]

In general, the larger the formed body density (that is, the closer the formed body density is to 100%), the smaller the amount of shrinkage during sintering. Therefore, in a case where the first formed body density P13 is made larger than the second formed body density P16 (P13 > P16), in the bonding and sintering step, the amount of shrinkage of the conductive layer pastes 13A, 14A, and 15A is smaller than the amount of shrinkage of the insulating layer pastes 16dA and 16eA. In such a density condition, in a case where the thicknesses of the conductive layer pastes 13A, 14A, and 15A after drying are set to be equal to or more than the thicknesses of the insulating layer pastes 16dA and 16eA after drying, the electrode layers 13 and 14 and the power feeding portion bonding layer 15 become thicker than the insulating bonding layer 16 after bonding and sintering. As a result, the stress applied to the plate body 11 on the power feeding portion 30 increases during bonding and sintering, the withstand voltage of the plate body 11

deteriorates. Further, the stress applied to the insulating bonding layer 16 decreases, and the withstand voltage of the insulating layer also deteriorates.

[0138]

On the other hand, even in a case where the first formed body density P13 is a value equal to or lower than the second formed body density P16, when the difference therebetween is too large (for example, more than 20%), the electrode layers 13 and 14 and the power feeding portion bonding layer 15 may become too thinner than the insulating bonding layer 16 after bonding and sintering, and the electrical resistance between the power feeding portion 30 and the electrode layers 13 and 14 and the power feeding portion bonding layer 15 may deteriorate.

[0139]

By setting the difference between the first formed body density P13 and the second formed body density P16 to the above-described range, the insulating bonding layer 16 is sufficiently densified in the bonding and sintering step to increase the withstand voltage, the electrode layers 13 and 14 and the power feeding portion bonding layer 15 are well bonded to the plate body 11 and the power feeding portion 30 to reduce the electrical resistance, and the withstand voltage of the plate body 11 on the power feeding portion 30 can be maintained in good condition.

[0140]

In general, the formed body density is lower as a particle size distribution of the powder to be formed is narrower, and the formed body density is higher in a powder having a wider particle size distribution. The conductive layer pastes 13A, 14A, and 15A, which are a mixture of insulating powder and conductive powder, have a wider particle size distribution than the insulating layer pastes 16dA and 16eA using a single insulating powder. Therefore, the formed body using the conductive layer paste has a higher formed body density (is more dense). Therefore, by using insulating powder and conductive powder having values of particle diameters

close to each other as the insulating powder and the conductive powder used for the conductive layer pastes 13A, 14A, and 15A, the particle size distribution can be narrowed, and the formed body density of the conductive layer pastes 13A, 14A, and 15A after drying can be reduced. As other methods of reducing the formed body density of the conductive layer pastes 13A, 14A, and 15A after drying, a method of adding powder with a low bulk density to the powder used for the conductive layer pastes 13A, 14A, and 15A, or the like is also possible. As the powder with a low bulk density, aluminum oxide powder with a γ-type crystal phase or the like is suitably used, and as the insulating powder, a mixture of aluminum oxide powder with an α-type crystal phase and γ-type aluminum oxide powder is preferably used. Since the γ-type aluminum oxide powder has strong cohesiveness and low bulk density, even in a case of being added to the α-type aluminum oxide powder, an effect of reducing the formed body density of the paste can be obtained. The γ-type aluminum oxide powder undergoes a phase transition by being heated in the bonding and sintering step, and becomes α-type aluminum oxide powder. In addition, it is preferable to use powder having a small particle diameter as insulating powder used for the insulating layer pastes 16dA and 16eA. Since powder having a small particle diameter has higher activity during sintering than powder having a large particle diameter, by reducing the particle diameter of the insulating powder used for the insulating layer pastes 16dA and 16eA, the withstand voltage after bonding the base body 10 and the insulating bonding layer 16 can be increased in the bonding and sintering step. A proportion of the γ-type aluminum oxide powder can be optionally selected, and for example, a mass ratio of the α-type aluminum oxide powder to the γ-type aluminum oxide powder may be 99:1 to 90:10, or may be 98:2 to 95:5, but is not limited to these examples.

[0141]

In the printing step, the insulating layer paste 16dA and the conductive layer paste 13A may be applied to the second plate body 11b, or may be applied to the first plate body 11a. In

addition, the insulating layer paste 16eA and the conductive layer pastes 14A and 15A may be applied to the third plate body 11c, or these may be applied to the second plate body 11b.

[0142]

(Bonding and Sintering Step)

A bonding and sintering procedure is a procedure of overlapping the first plate body 11a, the second plate body 11b, and the third plate body 11c with surfaces to which the paste is applied interposed therebetween, and hot pressing the plate bodies under a high temperature and a high pressure to integrally bond the plate bodies. After the paste is applied, it is dried before bonding as necessary.

[0143]

More specifically, as shown in FIG. 5, the bonding and sintering step according to the present embodiment is a step of bonding and integrating the first plate body 11a, the second plate body 11b, the third plate body 11c, the first power feeding portion 31 inserted into the first through-hole 12a of the second plate body 11b, the second power feeding portion 32 inserted into the second through-hole 12b of the third plate body 11c, the third power feeding portion 33 inserted into the third through-hole 12c of the third plate body 11c, the first electrode layer 13 disposed between the first plate body 11a and the second plate body 11b, the second electrode layer 14 disposed between the second plate body 11b and the third plate body 11c, and the power feeding portion bonding layer 15 disposed between the first power feeding portion 31 and the second power feeding portion 32.

[0144]

In the bonding and sintering procedure, the first plate body 11a, the second plate body 11b, and the third plate body 11c are sintered at a temperature of 1400°C to 1900°C, in a non-oxidative atmosphere, preferably in an inert atmosphere, for a predetermined time while being pressurized in the thickness direction at 1 MPa to 50 MPa. With such a hot pressing procedure,

the applied insulating layer paste 16dA becomes the first insulating bonding layer 16d to integrally bond the first plate body 11a and the second plate body 11b, the conductive layer paste 13A is sintered to form the first electrode layer 13, the insulating layer paste 16eA is sintered to form the second insulating bonding layer 16e, the conductive layer paste 14A is sintered to form the second electrode layer 14, and the conductive layer paste 15A is sintered to form the power feeding portion bonding layer 15, and the layers are integrally bonded by sintering. The first power feeding portion 31 is integrally bonded to the first electrode layer 13, the power feeding portion bonding layer 15, and the second plate body 11b. The second power feeding portion 32 is integrally bonded to the power feeding portion bonding layer 15 and the third plate body 11c. The third power feeding portion 33 is integrally bonded to the second electrode layer 14 and the third plate body 11c. It is preferable that the power feeding portion 30 and the plate body 11 are densely bonded at the boundary therebetween without a gap or almost without a gap.

[0145]

In the present embodiment, a case where the first plate body 11a, the second plate body 11b, and the third plate body 11c are stacked in the thickness direction and simultaneously bonded has been described. The first plate body 11a, the second plate body 11b, and the third plate body 11c are stacked in the thickness direction and simultaneously bonded, so that the numbers of times the first plate body 11a, the second plate body 11b, and the third plate body 11c are heat-treated while being pressurized by hot pressing are the same as each other.

[0146]

For example, in a case where the second plate body 11b and the third plate body 11c are bonded after the first plate body 11a and the second plate body 11b are bonded, the first plate body 11a and the second plate body 11b undergo the bonding and sintering step twice, and the third plate body 11c undergoes the bonding and sintering step once. In this case, the first plate body 11a, the second plate body 11b, the first insulating bonding layer 16d, the first electrode layer 13,

and the first power feeding portion 31 may be excessively heat-treated, and the particle diameter of the main component may increase. In addition, the particle diameters of the main components of the first plate body 11a, the second plate body 11b, and the third plate body 11c may be different from each other, which may deteriorate the durability of the base body 10. However, in a case where the thermal history applied to the plate body 11 is appropriately set so that the particle diameter of the main component of the member constituting each plate body 11 is the same as in a case where the bonding and sintering step is performed once, the bonding between the first plate body 11a and the second plate body 11b and the bonding between the second plate body 11b and the third plate body 11c may be performed in separate steps. By separately performing the bonding between the first plate body 11a and the second plate body 11b and the bonding between the second plate body 11b and the third plate body 11c, the dimensional accuracy of the thickness of the plate body 11 can be improved.

[0147]

In a case where the bonding and sintering step is performed twice, in order to make the particle diameters of the main components of the first plate body 11a, the second plate body 11b, and the third plate body 11c substantially the same, it is preferable to use a material having little particle growth due to sintering, such as an aluminum oxide-silicon carbide (Al_2O_3-SiC) composite sintered body as the forming materials of the first plate body 11a, the second plate body 11b, and the third plate body 11c.

[0148]

(Brazing Step)

The brazing step is a step of connecting the terminal member to the lower end surface of the power feeding portion with a brazing agent interposed therebetween. For example, as shown in FIG. 2 and the like, the brazing step is a step of connecting the terminal member 35 to the lower end surface 33t of the third power feeding portion 33 or the like. In addition, although the

illustration in FIG. 2 and the description here are omitted, the terminal member 35 can also be connected to the lower end surface of the second power feeding portion, for example, the lower end surface 32t of the second power feeding portion 32, by the same procedure as the third power feeding portion 33 (see FIG. 1).

[0149]

For example, in the brazing step, first, the recess 33a is formed on the lower end surface 33t of the third power feeding portion 33. Further, the bottom surface 33b of the recess 33a is coated with a brazing agent, and overlapped with the third power feeding portion 33 and heat-treated. As a result, the lower end surface 33t of the third power feeding portion 33 and the upper end portion of the third power feeding portion 33 are brazed. During the heat treatment, the brazing agent melts and spreads from a position at which the brazing agent is applied, but the brazing agent remains inside the recess 33a of the lower end surface 33t of the third power feeding portion 33. By passing through this step, the brazed portion 5 is formed between the third power feeding portion 33 (and the second power feeding portion 32) and the terminal member 35. In a case where a recess is formed, as shown in FIG. 2, a recess may be provided on the lower surface of the power feeding portion, or as shown in FIG. 3, a recess may be formed on the lower surface of the plate body. In the latter case, the flat lower surface of the power feeding portion is exposed in the recess. As shown in FIG. 4, formation of a recess may be omitted.

The electrostatic chuck member 2 is manufactured through the above-described steps. In addition, the manufactured electrostatic chuck member 2 is mounted on the base member 3 provided with the terminal insulator 23. As a result, the electrostatic chuck device 1 is manufactured.

Examples

[0150]

(Production of Sample)

An electrostatic chuck member of each sample of Examples 1 to 5 and Comparative Examples 1 to 3 was produced through the steps described in the above manufacturing method, except for other steps described below. For example, Examples 1 to 3 are samples formed by the method as shown in FIG. 5. Examples 1 to 5 had a power feeding portion bonding layer and Comparative Examples 1 to 3 did not have a power feeding portion bonding layer. The sample was produced such that the diameter of the base body to be produced was 300 mm, the thickness of the first plate body was 0.4 mm, the thickness of the second plate body was 5 mm, and the thickness of the third plate body was 5 mm. The widths of the first insulating bonding layer 16d and the second insulating bonding layer 16e were set to 1 mm.

[0151]

In the above-described plate body sintering step, the first plate body, the second plate body, and the third plate body were produced by forming and sintering a mixed powder of 90% by volume of aluminum oxide powder and 10% by volume of silicon carbide powder. In addition, in the power feeding portion sintering step, the conductive sintered bodies serving as the first power feeding portion, the second power feeding portion, and the third power feeding portion were produced by forming and sintering a mixed powder of 65% by volume of aluminum oxide powder and 35% by volume of molybdenum carbide powder.

[0152]

In the machining step, the outer diameters of the first power feeding portion, the second power feeding portion, and the third power feeding portion were set to 4 mm, and the lengths thereof were set to 5 mm.

[0153]

In the printing step, a thickness of the applied paste was set such that a thickness after drying was 80 μm for both the conductive layer paste (electrode layer paste and power feeding portion bonding layer paste) and the insulating layer paste. Two types of conductive layer pastes

([A] and [B]) and one type of insulating layer paste ([C]) were prepared and used. The pastes were applied to be arranged as shown in FIG. 1, FIG. 5, and Table 1.

[0154]

In the bonding and sintering step, after the conductive layer paste ([A] or [B]) and the insulating layer paste ([C]) were applied, the first power feeding portion, the second power feeding portion, and the third power feeding portion were inserted into the respective through-holes, and the first plate body, the second plate body, and the third plate body were stacked to form a stacked body. Then, in an argon atmosphere, the stacked body was sintered and integrally bonded while being heated at a heat treatment temperature of 1700°C and a pressure of 10 MPa.

[0155]

In addition, a terminal member was provided on the lower surface of the second power feeding portion and the third power feeding portion.

An outer diameter of the terminal member was set to 6 mm. A recess having a diameter of 6.5 mm and a depth of 0.5 mm was provided on the lower surface of the second and third power feeding portions and in the periphery thereof, and the power feeding portions and the terminal member were brazed in the recess.

In addition, detailed configurations of each sample are shown in Table 1 below. Parameters of each sample in Table 1 will be described.

[0156]

(The Number of Times of Hot Pressing)

Table 1 shows the number of times of hot pressing of Examples 1 to 5 and Comparative Examples 1 to 3. In Table 1, the phrase “The number of times of hot pressing” represents the number of times hot pressing was performed in the bonding and sintering step. In a case where the number of times of hot pressing was one, the first plate body, the second plate body into which the first power feeding portion was inserted, and the third plate body into which the second power

feeding portion and the third power feeding portion were inserted were stacked in a state in which the conductive layer paste and the insulating layer paste were applied, and were pressurized in the thickness direction. In a case where the number of times of hot pressing was two, the first plate body and the second plate body into which the first power feeding portion was inserted were bonded by the first hot pressing, and then the third plate body into which the second power feeding portion and the third power feeding portion were inserted was bonded by the second hot pressing.

[0157]

(Presence or Absence of Power Feeding Portion Bonding Layer)

Table 1 shows presence or absence of a power feeding portion bonding layer in Examples 1 to 5 and Comparative Examples 1 to 3.

In Table 1, the term “Power feeding portion bonding layer” indicates the presence or absence of the power feeding portion bonding layer. In a case where the power feeding portion bonding layer was “Present”, the power feeding portion bonding layer was provided between the first power feeding portion and the second power feeding portion to be bonded to each other, and the second power feeding portion, the first power feeding portion, and the first electrode layer were electrically connected. In Comparative Example 1, in which the power feeding portion bonding layer was “Absent”, one power feeding portion (sintered) in which the first power feeding portion and the second power feeding portion were formed in succession and communicated with each other was inserted into the second plate body and the third plate body, and the second plate body and the third plate body were bonded and sintered. In Comparative Example 2, after a sample was formed in the same manner as in Example 1, except that the second power feeding portion and the power feeding portion bonding layer were not provided, a recess reaching from the lower surface of the base body to the first power feeding portion was provided after the bonding and sintering step. Therefore, in Comparative Example 2, a location where the power feeding portion bonding layer was located was ground, and an inner side of the concave portion was

formed. In Comparative Example 3, the power feeding portion bonding layer was not provided between the first power feeding portion and the second power feeding portion, and the first power feeding portion and the second power feeding portion were directly bonded without the power feeding portion bonding layer.

[0158]

(Pre-Bonding Gap)

Table 1 shows a pre-bonding gap of Examples 1 to 5 and Comparative Examples 1 to 3.

A sample in which the gap between the first through-hole 12a and the first power feeding portion 31, the gap between the second through-hole 12b and the second power feeding portion 32, and the gap (pre-bonding gap) between the third through-hole 12c and the third power feeding portion were changed in the machining step was produced. Table 1 shows the pre-bonding gap of each sample. In Examples 1, 3, and 4 and Comparative Examples 2 and 3 in Table 1, for a difference between the outer diameter of the through-hole and the outer diameter of the power feeding portion, the through-hole was set to be larger than the power feeding portion by 0.05 mm. In Examples 2 and 5 and Comparative Example 1, the through-hole was set to be larger than the power feeding portion by 0.1 mm.

[0159]

(Paste Composition)

Table 1 shows the type (paste composition) of a conductive layer paste (the same paste was used for an electrode layer paste and a power feeding portion bonding layer paste) used in Examples 1 to 5 and Comparative Examples 1 to 3. For Examples and Comparative Examples, two types of conductive layer pastes ([A] and [B]) and one type of insulating layer paste ([C]) were prepared and used in the screen printing step.

In the screen printing step, in a case where the paste composition shown in Table 1 was indicated as [A], as the conductive layer paste ([A]), a paste (conductive layer paste) obtained by

dispersing aluminum oxide having an average particle diameter of 1 μm, a bulk density (tap density) of 1.4 g/cm^3, and an α-type crystal phase, aluminum oxide powder having a bulk density (tap density) of 0.2 g/cm^3 and a γ-type crystal phase, and molybdenum carbide powder having an average particle diameter of 1 μm in a solvent for screen printing was used. The α-type aluminum oxide powder and the γ-type aluminum oxide powder were mixed with each other such that the γ-type aluminum oxide powder was 3% by mass, and used as mixed aluminum oxide powder. The content of the mixed aluminum oxide powder in the conductive layer paste and the power feeding portion paste was set to 65% by volume, and the content of the molybdenum carbide powder was set to 35% by volume.

[0160]

In the screen printing step, in a case where the paste composition shown in Table 1 was indicated as [B], as the conductive layer paste ([B]), a paste (conductive layer paste) obtained by dispersing aluminum oxide having an average particle diameter of 0.1 μm, a bulk density (tap density) of 1.0 g/cm^3, and an α-type crystal phase and molybdenum carbide powder having an average particle diameter of 1 μm in a solvent for screen printing was used. The content of the aluminum oxide powder in the conductive layer paste was set to 65% by volume, and the content of the molybdenum carbide powder was set to 35% by volume.

In addition, the insulating layer paste ([C]) was used together with [A] and [B] in Table 1, and a paste (insulating layer paste) obtained by dispersing aluminum oxide powder having an average particle diameter of 0.1 μm, a bulk density (tap density) of 1.0 g/cm^3, and an α-type crystal phase in a solvent for screen printing was used as the insulating layer paste ([C]).

[0161]

(Structure of Power Feeding Portion)

Table 1 shows a structure of a power feeding portion used in Examples 1 to 5 and Comparative Examples 1 to 3.

In “Structure of power feeding portion” in Table 1, a structure of the power feeding portion connected to the second electrode layer is described in an upper row of each sample, and a structure of the power feeding portion connected to the first electrode layer is described in a lower row. In the sample described as “Third power feeding portion” in the upper row, as in the above-described embodiment, the third power feeding portion that was integrally bonded to the third plate body was provided, and the terminal member was connected and brazed to the lower surface of the third power feeding portion. Similarly, in the sample described as “First and second power feeding portions” in the lower row, as in the above-described embodiment, the second plate body was provided with the first power feeding portion, the third plate body was provided with the second power feeding portion, which were connected by the power feeding portion bonding layer, and the terminal member was brazed on the lower surface of the second power feeding portion. In the sample described as “First power feeding portion” in the lower row, a recess reaching from the lower surface of the base body to the first power feeding portion was provided, and a terminal was connected and brazed to the lower surface of the first power feeding portion in the recess.

[0162]

The sample described as “*1” in the lower row of “Structure of power feeding portion” in Table 1 is a sample in which the first electrode layer and the like were subjected to hot pressing of bonding and sintering in a state in which one power feeding portion (corresponding to an integrated body of the first power feeding portion and the second power feeding portion) that communicates the through-holes provided in the second plate body and the third plate body was inserted into the through-holes provided in the second plate body and the third plate body. Therefore, in the sample of “*1”, one power feeding portion penetrating the second plate body and the third plate body extended from the first electrode layer to the lower surface side of the base

body, and the terminal was connected and brazed to the lower surface of the power feeding portion penetrating the second plate body and the third plate body.

[0163]

(Post-Bonding Gap)

Table 1 shows post-bonding gaps measured for the samples of Examples 1 to 5 and Comparative Examples 1 to 3.

In Table 1, the term “Post-bonding gap” means a gap at a boundary between the outer peripheral surfaces of the first power feeding portion, the second power feeding portion, and the third power feeding portion and the base body after the bonding and sintering step. In a case where the outer peripheral surfaces of the first power feeding portion, the second power feeding portion, and the third power feeding portion, and the base body were densely bonded at the boundary therebetween, the gap was defined as “Absent”. Whether the power feeding portion and the plate body were densely bonded at the boundary therebetween was determined by using an ultrasonic flaw detector. It was determined whether or not the region in which the reflected waves caused by the gap between the power feeding portion and the plate body were confirmed in a range of 1 mm from the outer periphery of the power feeding portion was 50% or less of the entire circumference, and in a case where the region in which the reflected waves could be confirmed in a range of 1 mm from the outer periphery of the power feeding portion was 20% or less, it was determined that the power feeding portion and the plate body were densely bonded at the boundary therebetween, and the gap was defined as “Absent”. The measurement was performed under measurement conditions of the ultrasonic flaw detector with an oscillation (ultrasound) frequency set to 50 MHz, a focal length set to 40 mm, and a focus aligned with the lower surface of the power feeding portion in water.

[0164]

(Electrical Resistance between Power Feeding Portion and Electrode Layer)

Table 1 shows electrical resistances measured for the samples of Examples 1 to 5 and Comparative Examples 1 to 3.

For “Electrical resistance between power feeding portion and electrode layer” shown in Table 1, using a sample before the terminal member was attached by brazing, the electrode layer was exposed by providing a through-hole reaching from the upper surface of the base body to the electrode layer, and the electrical resistance between the electrode layer and the lower surface of the power feeding portion was measured. In a case of exposing the electrode layer, the electrode layer was exposed at a position that does not overlap with the position of the power feeding portion and that is separated from the power feeding portion by 10 mm.

[0165]

In a case where the electrical resistance between the power feeding portion and the electrode layer is 10 Ω or higher and lower than 10 MΩ, the electrode layer can be used as an electrode for electrostatic adsorption, but in a case of being used as an RF electrode or a heater electrode, the heat generation due to an electric current may increase. In a case where the electrical resistance between the power feeding portion and the electrode layer is 10 MΩ or higher, even when the electrode layer is used as an electrode for electrostatic adsorption, adsorption responsiveness deteriorates, so that there is a high possibility that it cannot be used.

[0166]

In a case where the electrical resistance between the power feeding portion and the electrode layer is 10 Ω or lower, more preferably 1 Ω or lower, the electrode layer can be suitably used as any of an electrode for electrostatic adsorption, an RF electrode, or a heater electrode. In