

SUBSTRATE CLAMP AND SUBSTRATE TREATMENT APPARATUS

FIELD OF THE INVENTION

The present invention relates to the technical field of semiconductor processing, and further relates to a substrate clamp and a substrate treatment apparatus.

BACKGROUND

Wet etching is a type of etching process. In wet etching processes, variations in the etching amount of an etching solution may occur due to equipment-related factors (such as control precision of etching time or etching solution temperature) or the service life of the etching solution itself, resulting in unstable etching rates. Consequently, the etched products exhibit poor thickness uniformity, as well as defects such as color variations and pitting. Additionally, excessive lateral etching (Undercut) severely affects product quality.

In the prior art, a technical solution using a stripping process to replace the wet etching process has been disclosed. For example, Chinese Patent Application No. 202111140314.8 provides a method for preparing a patterned electrode using a stripping process and a patterned electrode using the above method. This method omits the wet etching step, thereby avoiding various problems caused by wet etching. The principle of the above-mentioned stripping process is: Stripping is the reverse process of electroplating. When a substrate plated with a metal film functions as a working electrode (anode), the metal portion without photoresist protection will lose electrons and become metal ions that will be dissolved in an electroplating solution. After the surface metal is dissolved, the conductive seed metal layer will also lose electrons and be dissolved, while the metal portion protected by the photoresist is retained, so that the purpose of electrode patterning can be achieved.

The structure of a substrate stripping apparatus is similar to the structure of a substrate electroplating apparatus. However, in some existing electroplating apparatus, a substrate clamp used for electroplating is provided with a seal, and the substrate clamp is isolated from the electroplating solution through the seal. This can prevent the current in the electroplating solution from being directly conducted to the substrate

clamp without passing through the substrate surface, resulting in the value of the current conducted from the electroplating solution to the substrate surface being lower than the theoretical value, thereby affecting the actual plating thickness. In the substrate electroplating process, while the seal blocks the direct contact between the electroplating solution and the substrate clamp, the seal also blocks the contact between the electroplating solution and the substrate edge. However, in the substrate electroplating process, only one side of the substrate needs to be electroplated, and the substrate edge does not need to be electroplated, so the seal will not affect the substrate electroplating. In the substrate stripping process, it is necessary to strip the entire surface of the substrate. If the above-mentioned seal is used, the edge area of the substrate cannot be stripped. Therefore, the above-mentioned seal is not suitable for stripping. However, in the substrate stripping process, if the substrate clamp is in direct contact with the electroplating solution, part of the current in the electroplating solution will still be directly conducted to the substrate clamp, making the value of the current conducted from the electroplating solution to the substrate surface lower than the theoretical value, which reduces the stripping amount on the substrate surface, and affects the stripping effect.

Therefore, the present application aims to provide a substrate clamp to reduce the electrical contact between the substrate clamp and a treatment solution during the substrate liquid treatment.

SUMMARY

In view of the above technical problems, the purpose of the present invention is to provide a substrate clamp and a substrate treatment apparatus to reduce the electrical contact between the substrate clamp and a treatment solution during the substrate treatment.

In some embodiments, the above-mentioned substrate clamp is used to secure a substrate within a process chamber, the process chamber is used to contain the treatment solution, and the substrate clamp comprises: a plurality of support members, mounted on a fixing ring and sequentially arranged along the circumferential direction of an opening, each support member including a connecting portion and a contact which are conductively connected, the surface of the connecting portion being

provided with an insulating layer, and the contact being used for electrically contacting the substrate. Wherein, the contact is connected to the fixing ring at a preset distance through the connecting portion, so that during the substrate treatment, the fixing ring is located above the liquid level of the treatment solution, and the contact and the substrate carried on the contact are located below the liquid level.

In some embodiments, the above-mentioned substrate treatment apparatus comprises a substrate clamp, a process chamber, an electrode, and a power supply.

Compared with the prior art, the beneficial effects of the present application are: the substrate clamp disclosed in the present application comprises a fixing ring and a plurality of support members mounted on the fixing ring. The support members can not only play a role of carrying a substrate but also play a role of conducting electricity to the substrate. In addition, each support member further includes a connecting portion and a contact connected in sequence. The contact is kept at a preset distance from the fixing ring through the connecting portion, so that during the substrate treatment, the fixing ring can be located above the liquid level of the treatment solution, and the contact and the substrate carried on the contact are located below the liquid level, thereby avoiding the contact between the fixing ring and the treatment solution, and enabling the substrate to be completely immersed in the treatment solution, further reducing the electrical contact between the substrate clamp and the treatment solution during the substrate treatment, and improving the accuracy of the substrate treatment.

BRIEF DESCRIPTION OF THE DRAWINGS

The above characteristics, technical features, advantages, and embodiments of the present invention will be further described below in a clear and understandable manner by preferred embodiments are illustrated with reference to accompanying drawings.

FIG. 1 is a schematic diagram of the overall structure of an embodiment of the substrate clamp of the present invention;

FIG. 2 is a schematic three-dimensional structure diagram of a fixing ring of an embodiment of the substrate clamp of the present invention;

FIG. 3 is a top view of FIG. 2;

FIG. 4 is a schematic structural diagram of a support member of an embodiment of the substrate clamp of the present invention;

FIG. 5a is a schematic structural diagram of a support member of another embodiment of the substrate clamp of the present invention;

FIG. 5b is a schematic diagram of another embodiment of FIG. 5a;

FIG. 6 is a schematic structural diagram of a guide member of an embodiment of the substrate clamp of the present invention;

FIG. 7 is a schematic structural diagram of a pressure plate of an embodiment of the substrate clamp of the present invention;

FIG. 8 is a bottom view of FIG. 7;

FIG. 9 is a bottom view of an embodiment of the substrate clamp of the present invention in a state of loading a substrate;

FIG. 10 is a partial enlarged view of area a in FIG. 9;

FIG. 11 is a schematic three-dimensional structure diagram of a second pressure column of an embodiment of the substrate clamp of the present invention;

FIG. 12 is a schematic diagram of an embodiment of the substrate clamp of the present invention during the period of loading a substrate;

FIG. 13 is a schematic diagram of an embodiment of the substrate clamp of the present invention during the period of loading a substrate;

FIG. 14 is a schematic diagram of an embodiment of the substrate clamp of the present invention during the period of loading a substrate;

FIG. 15 is a schematic diagram of an embodiment of the substrate clamp of the present invention after the completion of loading a substrate.

PREFERRED EMBODIMENTS OF THE INVENTION

In order to further clarify the embodiments of the present invention or the technical solutions in the prior art, the specific embodiments of the present invention will be described below with reference to the accompanying drawings. Obviously, the drawings in the following description are only some embodiments of the present invention. For those of ordinary skill in the art, other drawings and other embodiments can be obtained according to these accompanying drawings without making creative efforts.

To make the drawings concise, only the portions related to the invention are schematically shown in each drawing, and the portions do not represent the actual structure of the product. In addition, to make the drawings concise and easy to understand, in some drawings, only one of the components with the same structure or function is schematically shown or marked. In this document, "one" not only means "only one" but also can mean "more than one".

In this document, it should be noted that unless otherwise clearly specified and limited, the terms "mount," "interconnect," and "connect" should be understood in a broad sense. For example, the connection can be a fixed connection, a detachable connection, or an integral connection; the connection can be a mechanical connection or an electrical connection; the connection can be a direct connection, an indirect connection through an intermediate medium, or an internal connection between two elements. For those of ordinary skill in the art, the specific meanings of the above terms in the present invention can be understood according to specific circumstances.

In addition, in the description of the present application, the terms "first," "second," and the like are only used for distinguishing descriptions, and cannot be understood as indicating or implying relative importance.

As shown in FIGS. 1 to 3, the present invention discloses a substrate clamp 200 for securing a substrate 300 within a process chamber 100 of a substrate treatment apparatus. The process chamber 100 is used to contain a treatment solution. The substrate clamp 200 comprises a fixing ring 210 and a plurality of support members 220.

Specifically, the fixing ring 210 is configured to have an opening 214 for receiving

the substrate 300, and the shape of the opening 214 is basically consistent with the shape of the substrate 300. The support members 220 are arranged on the fixing ring 210 and sequentially arranged along the circumferential direction of the opening 214 of the fixing ring 210. Each support member 220 further includes a connecting portion 226 and a contact 223 which are conductively connected.

The contacts 223 are used for electrically contacting the substrate 300. The contacts 223 are connected to the fixing ring 210 at a preset distance through the connecting portions 226, so that during the treatment of the substrate 300, the fixing ring 210 is located above the liquid level 110 of the treatment solution, and the contacts 223 and the substrate 300 carried on the contacts 223 are located below the liquid level 110. Since only the support members 220 are in contact with the treatment solution, the contact between the fixing ring 210 and the treatment solution is avoided, and the current in the treatment solution is prevented from being directly conducted to the fixing ring 210 without passing through the surface of the substrate 300. In addition, an insulating layer 224 is provided on the surface of each connecting portion 226, which can further reduce the electrical contact between the substrate clamp 200 and the treatment solution.

In addition, the above-mentioned insulating layers 224 can be plastic sleeves or plastic coatings, and the material of the insulating layers 224 includes but is not limited to polytetrafluoroethylene (PTFE). The connecting portions 226 and the contacts 223 are made of conductive materials, such as titanium.

Preferably, the connecting portions 226 are bent members with a certain elasticity. As shown in FIG. 2, in this embodiment, each connecting portion 226 includes a first connecting portion 221 and a second connecting portion 222. One end of the first connecting portion 221 is fixedly connected to the fixing ring 210, the other end of the first connecting portion 221 extends from the fixing ring 210 to a direction away from the fixing ring 210 by a preset length, and the second connecting portion 222 extends from the other end of the first connecting portion 221 to the vertical projection range of the opening 214 and is connected to the contact 223. The included angle between the first connecting portion 221 and the second connecting portion 222 is denoted as θ (referred to as the bending angle θ of the connecting portion 226). When the substrate clamp 200 is not loaded with the substrate 300, the bending angle θ of the connecting

portion 226 is 90 degrees or less than 90 degrees; when the substrate clamp 200 is loaded with the substrate 300, each contact 223 is under the pressure of the substrate 300, the bending angle θ becomes larger, and the bottom surface of the substrate 300 presses each contact 223 tightly.

As shown in FIG. 4, in a preferred embodiment of the present application, the connecting portion 226 is configured in a rod-shaped structure, the contact 223 is configured in a spherical structure, and the diameter of the contact 223 is larger than the cross-sectional diameter of the connecting portion 226. The surface of the contact 223 is provided with an insulating layer 224 except for an area 2231 that is in electrical contact with the substrate 300 carried on the surface of the contact 223, so as to minimize the direct contact between the contact 223 and the treatment solution.

As shown in FIG. 5a, in a preferred embodiment of the present application, the connecting portion 226 is configured in a rod-shaped structure, and the contact 223 includes a contact shell 2232, a contact main body 2233, a sealing ring 2234, and an elastic member 2236. Wherein, the contact shell 2232 is provided with a receiving groove 2235 along the vertical direction, one end of the contact main body 2233 extends out of the contact shell 2232, and the other end is installed in the receiving groove 2235 through the elastic member 2236. The sealing ring 2234 is arranged on the contact shell 2232 around the contact main body 2233. The connecting portion 226 and the contact main body 2233 are conductively connected. When the substrate clamp 200 is not loaded with the substrate 300, under the elastic force of the elastic member 2236, the end of the contact main body 2233 extending out of the contact shell 2232 is higher than the sealing ring 2234; during the process of loading the substrate 300 through the substrate clamp 200, after the substrate 300 contacts the end of the contact main body 2233 extending out of the contact shell 2232, the contact main body 2233 moves into the receiving groove 2235 under the pressure of the substrate 300 until the substrate 300 is in pressing contact with the sealing ring 2234, so as to isolate the contact main body 2233 from the treatment solution. Preferably, the surface of the contact shell 2232 is provided with an insulating layer 224 to minimize the direct contact between the contact 223 and the treatment solution. The above-mentioned elastic member 2236 includes, but is not limited to, a spring.

Preferably, as shown in FIG. 5b, the connecting portion 226 includes a wire 225

and a wire shell 227. The wire shell 227 is configured in a hollow rod-shaped structure and is in communication with the receiving groove 2235. The wire 225 is arranged in the wire shell 227 and is electrically connected to the contact main body 2233; wherein, the wire shell 227 serves as the insulating layer 224. It should be noted that in this embodiment, the wire shell 227 is entirely made of an insulating material, and the wire shell 227 has the function of the insulating layer 224 (as shown in FIG. 5b); in other embodiments, the wire shell 227 may also be made of a non-insulating material. To prevent electrical contact between the wire shell 227 and the treatment solution, the insulating layer 224 still needs to be provided outside the wire shell 227.

Preferably, each support member 220 can be configured such that the included angle α between the extending direction of the second connecting portion 222 and the radius r of the opening 214 is an acute angle (as shown in FIG. 3), preferably 45 degrees. This can increase the length of the second connecting portion 222 without increasing the distance between the contact 223 and the edge of the substrate 300, thereby increasing the variation of the included angle θ between the first connecting portion 221 and the second connecting portion 222 when the connecting portion 226 is elastically deformed under the external force. Therefore, during the process of the substrate clamp 200 carrying the substrate 300, the friction time between the bottom surface of the substrate 300 and the contact 223 is increased, so that the contact 223 is in full contact with the bottom surface of the substrate 300, the electrical conductivity is increased, and poor contact between the contact 223 and the substrate 300 is prevented.

As shown in FIGS. 2, 3, and 6, in a preferred embodiment of the present application, a plurality of guide members 211 are arranged at the bottom of the fixing ring 210. The guide members 211 are configured to have a sliding guide surface 212 facing the center of the opening 214, which is used to guide the substrate 300 to a preset position during the process of loading the substrate 300 through the substrate clamp 200. And when the substrate 300 is located at the above-mentioned preset position, the substrate 300 coincides with the center line of the opening 214.

Preferably, a limit pin 213 is arranged on the surface of the sliding guide surface 212, and the limit pin 213 protrudes from the sliding guide surface 212 into the vertical projection range of the opening 214. When the substrate clamp 200 is loaded with the

substrate 300, the limit pin 213 is not higher than the contacts 223, so as to prevent the substrate 300 from directly falling into a process tank when the support members 220 fail.

According to FIG. 1 again, in a preferred embodiment of the present application, the substrate clamp 200 further comprises a pressure plate 230 and a pressure plate driving device 240. The pressure plate 230 is used to abut against the back surface of the substrate 300 during the treatment of the substrate 300, so that the substrate 300 is in pressing contact with the contacts 223. The pressure plate driving device 240 is used to drive the pressure plate 230 to abut against or move away from the back surface of the substrate 300. In addition, when the pressure plate driving device 240, such as a cylinder, has a problem, resulting in the pressure plate 230 excessively pressing down on the substrate 300, the above-mentioned limit pin 213 can be used to prevent the support members 220 from being excessively deformed, causing the substrate 300 to fall and resulting in problems such as fragmentation.

Preferably, the pressure plate 230 has a lower surface 234 in contact with the fixing ring 210, and a buffer pad 235 is arranged on the lower surface 234 to reduce the impact on the fixing ring 210 during the descent of the pressure plate 230. The above-mentioned buffer pad 235 is preferably an annular gasket arranged at the opening 214 between the pressure plate 230 and the fixing ring 210.

Preferably, as shown in FIGS. 7 to 10, the above-mentioned pressure plate 230 includes a plurality of first pressure columns 231 and second pressure columns 232. The first pressure columns 231 are arranged at intervals on the edge of the side of the pressure plate 230 abutting against the substrate 300, and the first pressure columns 231 are in one-to-one correspondence with the contacts 223 (as shown in FIG. 10) for abutting against the edge area of the substrate 300. Since the acting forces of the corresponding first pressure columns 231 and contacts 223 on the substrate 300 are located at the same position on the front and back surfaces of the substrate 300, the forces on the two surfaces of the substrate are uniform, thereby avoiding damage to the substrate 300 caused by nonuniform forces on the front and back surfaces of the substrate 300. The second pressure columns 232 are arranged at intervals in the middle of the side of the pressure plate 230 abutting against the substrate 300 for abutting against the middle area of the substrate 300, so that the force on the surface of the

substrate 300 is more uniform. In addition, to prevent the residual of accumulated solution, the arrangement positions of the second pressure columns 232 should be staggered with the positions of the suction cups 141 of a manipulator 140 (as shown in FIG. 9).

Preferably, as shown in FIGS. 10 and 11, a plurality of diversion grooves 233 are arranged on the side of the first pressure columns 231 and the second pressure columns 232 abutting against the substrate 300. The diversion grooves 233 extend along the radial direction of the pressure plate 230, so that after the treatment of the substrate 300, during the process in which the substrate 300 rises with the substrate clamp 200 and leaves the treatment solution, the treatment solution retained on the surface (upper surface) of the substrate 300 leaves the surface of the substrate 300. Moreover, arranging the diversion grooves 233 on the side of the first pressure columns 231 and the second pressure columns 232 facing the bottom of the process chamber 100 can reduce the contact area between the bottoms of the first pressure columns 231 and the second pressure columns 232 and the surface of the substrate 300, and prevent the bottoms of the first pressure columns 231 and the second pressure columns 232 from adsorbing the substrate 300 when the pressure plate 230 rises after the treatment of the substrate 300, leading to the substrate 300 rising together with the pressure plate 230 and causing the substrate 300 to fall and be damaged.

Preferably, according to FIGS. 1 and 8 again, the side of the pressure plate 230 abutting against the substrate 300 is provided with a cavity structure 236. The first pressure columns 231 are located at the edge of the cavity structure 236, and the second pressure columns 232 are located in the middle of the cavity structure 236. The interior of the cavity structure 236 has an outwardly inclined side wall 2361 and an arched top 2362. In addition, during the treatment of the substrate 300, the substrate clamp 100 is configured such that the highest point of the top 2362 is located above the liquid level 110 of the treatment solution. The above-mentioned cavity structure 236 helps to reduce the contact area between the pressure plate 230 and the treatment solution during the substrate treatment, preventing the pressure plate 230 from adsorbing the substrate 300 when rising. In addition, the design of the side wall 2361 and the top 2362 of the cavity structure 236 helps to prevent the treatment solution from adhering to the interior of the cavity structure 236 and reduces the corrosion on the pressure

plate 230.

Preferably, in a preferred embodiment of the present application, the substrate clamp 200 further comprises a fixing plate 250 and support columns 260. Wherein, the fixing plate 250 is located above the fixing ring 210, and the fixing plate 250 and the fixing ring 210 are connected by the support columns 260. The pressure plate 230 is arranged between the fixing plate 250 and the fixing ring 210 in a liftable manner, and the edge of the pressure plate 230 is provided with guide holes 237 (as shown in FIGS. 7 and 8). The support columns 260 pass through the guide holes 237, so that the pressure plate 230, the fixing plate 250, and the fixing ring 210 are located on the same center line.

As shown in FIGS. 12 to 15, in practical application, the working steps of the substrate clamp 200 are as follows:

First, as shown in FIG. 12, the pressure plate 230 moves upward under the drive of the pressure plate driving device 240 and remains positioned above the fixing ring 210, and a certain distance exists between the pressure plate 230 and the fixing ring 210. At this time, the substrate 300 can be moved from the side of the substrate clamp 200 to the position between the pressure plate 230 and the fixing ring 210 by the manipulator 140;

Second, as shown in FIG. 13, the manipulator 140 continues to drive the substrate 300 to move downward. After the substrate 300 passes through the opening 214 of the fixing ring 210, the substrate 300 is finally placed on the support members 220. At this time, the contacts 223 of all support members 220 jointly support the substrate 300, and the manipulator 140 moves out from the position between the pressure plate 230 and the fixing ring 210. At this time, the pressure of the substrate 300 on the contacts 223 is equal to the gravity of the substrate 300;

Third, as shown in FIG. 14, the pressure plate 230 moves downward under the drive of the pressure plate driving device 240 and abuts against the back surface of the substrate 300 to make the substrate 300 in pressing contact with the contacts 223. At this time, the pressure of the substrate 300 on the contacts 223 is equal to the gravity of the substrate 300 plus the pressure of the pressure plate 230 on the substrate 300, so

that the support members 220 are elastically deformed, and the loading of the substrate 300 is completed;

Finally, as shown in FIG. 15, the substrate clamp 200 loaded with the substrate 300 is integrally moved downward into the process chamber 100 of the substrate treatment apparatus to treat the substrate 300.

The present invention also discloses a substrate treatment apparatus. According to FIG. 1, the substrate treatment apparatus comprises a process chamber 100, an electrode 120, a power supply 130, and the substrate clamp 200 in any of the above embodiments. Wherein, the electrode 120 is arranged in the process chamber 100, and the power supply 130 is used to provide currents of opposite electrical properties to the substrate clamp 200 and the electrode 120. Preferably, the substrate treatment apparatus is a stripping apparatus, and the power supply 130 is configured to provide a positive current to the substrate 300 and a negative current to the electrode 120.

Based on the special structure of the substrate clamp 200, this embodiment enables only the support members 220 to be in contact with the electrical treatment solution during the treatment of the substrate 300, avoids the contact between the fixing ring 210 and the treatment solution, and enables the substrate 300 to be completely immersed in the treatment solution, thereby reducing the electrical contact between the substrate clamp 200 and the treatment solution during the treatment of the substrate 300 and improving the accuracy of the treatment of the substrate 300.

It should be noted that the above embodiments can be freely combined as needed. The above embodiments are only the preferred embodiments of the present invention. For those of ordinary skill in the art, without departing from the principle of the present invention, some improvements and modifications can also be made, and these improvements and modifications should also be regarded as falling within the protection scope of the present invention.

What is claimed is:

1. A substrate clamp, for securing a substrate within a process chamber used to contain a treatment solution, comprising:

a fixing ring, configured to have an opening for receiving the substrate;

a plurality of support members, mounted on the fixing ring and sequentially arranged along the circumferential direction of the opening, each support member including a connecting portion and a contact which are conductively connected, an insulating layer being provided on the surface of the connecting portion, and the contact being used for electrically contacting the substrate;

wherein the contact is connected to the fixing ring at a preset distance through the connecting portion, so that during the substrate treatment, the fixing ring is located above the liquid level of the treatment solution, and the contact and the substrate carried on the contact are located below the liquid level.

2. The substrate clamp according to claim 1, wherein the connecting portion is configured in a rod-shaped structure; the contact is configured in a spherical structure, and the diameter of the contact is larger than the cross-sectional diameter of the connecting portion.

3. The substrate clamp according to claim 2, wherein the surface of the contact is provided with an insulating layer except for an area that is in electrical contact with the substrate carried on the surface of the contact.

4. The substrate clamp according to claim 1, wherein the contact includes a contact shell, a contact main body, an elastic member, and a sealing ring, the contact shell is provided with a receiving groove, one end of the contact main body extends out of the contact shell for electrically contacting the substrate, the other end of the contact main body is resiliently mounted in the receiving groove through the elastic member, and the sealing ring is arranged on the contact shell and surrounds the periphery of the end of the contact main body extending out of the contact shell;

the connecting portion and the contact main body are conductively connected;

when the substrate clamp is not loaded with the substrate, under the elastic force of the elastic member, the end of the contact main body extending out of the contact shell is higher than the sealing ring;

during the process of loading the substrate through the substrate clamp, the contact main body moves into the receiving groove under the pressure of the substrate until the substrate is in pressing contact with the sealing ring, so as to isolate the contact main body from the treatment solution.

5. The substrate clamp according to claim 4, wherein the connecting portion includes a wire and a wire shell, the wire shell is configured in a hollow rod-shaped structure and is in communication with the receiving groove, the wire is arranged in the wire shell and is electrically connected to the contact main body; and the wire shell serves as the insulating layer.

6. The substrate clamp according to claim 4, wherein the surface of the contact shell is provided with an insulating layer.

7. The substrate clamp according to claim 1, wherein the contact is made of titanium.

8. The substrate clamp according to claim 1, wherein the connecting portion includes a first connecting portion and a second connecting portion, one end of the first connecting portion is fixedly connected to the fixing ring, the other end of the first connecting portion extends from the fixing ring to a direction away from the fixing ring by a preset length, the second connecting portion extends from the other end of the first connecting portion to the vertical projection range of the opening and is connected to the contact; and the included angle between the extending direction of the second connecting portion and the radial direction of the opening is an acute angle.

9. The substrate clamp according to claim 1, wherein a plurality of guide members are arranged at the bottom of the fixing ring, and the guide members are configured to have a sliding guide surface facing the center of the opening for guiding the substrate to a preset position during the process of loading the substrate through the substrate clamp.

10. The substrate clamp according to claim 9, wherein a limit pin is arranged on the surface of the sliding guide surface, and the limit pin protrudes from the sliding guide surface into the vertical projection range of the opening, when the substrate clamp is loaded with the substrate, the limit pin is not higher than the contact.

11. The substrate clamp according to claim 1, further comprising:

a pressure plate, for abutting against the back surface of the substrate to make the substrate in pressing contact with the contact;

a pressure plate driving device, for driving the pressure plate to abut against or move away from the back surface of the substrate.

12. The substrate clamp according to claim 11, the pressure plate including:

a plurality of first pressure columns, arranged at intervals on the edge of the side of the pressure plate abutting against the substrate, and the first pressure columns being in one-to-one correspondence with the contacts for abutting against the edge area of the substrate;

a plurality of second pressure columns, arranged at intervals in the middle of the side of the pressure plate abutting against the substrate for abutting against the central area of the substrate.

13. The substrate clamp according to claim 12, wherein a plurality of diversion grooves are arranged on the side of the first pressure columns and/or the second pressure columns abutting against the substrate.

14. The substrate clamp according to claim 12, wherein a buffer pad is configured between the pressure plate and the fixing ring.

15. The substrate clamp according to claim 12, wherein the side of the pressure plate abutting against the substrate is provided with a cavity structure, the first pressure columns are located at the edge of the cavity structure, the second pressure columns are located in the middle of the cavity structure; the interior of the cavity structure has an outwardly inclined side wall, and/or the interior of the cavity structure has an arched

top.

16. The substrate clamp according to claim 15, wherein, during the treatment of the substrate, the substrate clamp is configured such that the highest point of the top is located above the liquid level of the treatment solution.

17. A substrate treatment apparatus, including the substrate clamp according to any one of claims 1 to 16, further comprising:

a process chamber;

an electrode, arranged in the process chamber;

a power supply, for providing currents of opposite electrical properties to the substrate and the electrode.