

SUBSTRATE ELECTROPLATING APPARATUS AND METHOD

FIELD OF THE INVENTION

The present application relates to the field of semiconductor manufacturing equipment, and in particular, to a substrate electroplating apparatus and a substrate electroplating method.

BACKGROUND

During the wafer entry stage of a wafer electroplating process, a power supply needs to output a ramp current to maintain a constant current density on a wafer immersed in an electroplating solution. For a multi-anode electroplating apparatus, taking a dual-anode electroplating apparatus as an example, two anodes are respectively controlled by independent power supplies, and mutual interference is inevitably generated between the output currents of the two independent power supplies. Especially in a power supply mode switching stage, for example, when the power supply mode is switched from a constant voltage mode before entry to a constant current mode during the entry stage, the output currents of the two independent power supplies will deviate from a preset value for a short time. As shown in FIG. 2, FIG. 2 is a schematic diagram of a current-time curve output by a power supply of an exemplary substrate electroplating apparatus, undesired fluctuations are generated in an X area on the current curves of the two power supplies due to the interference between the two power supplies.

Since the copper electroplating entry stage usually lasts for milliseconds, the current fluctuation caused by the interference between power supplies will have a great impact on the stability of the electroplating process during the copper electroplating entry stage. Therefore, it is urgent to provide a solution that can reduce or even eliminate the current fluctuation caused by the mutual interference between multiple power supplies during the entry stage of multi-anode electroplating.

SUMMARY

In view of the above-mentioned shortcoming of the prior art, an object of the

present invention is to provide a substrate electroplating apparatus and a substrate electroplating method, which are used to solve the technical problem of current fluctuation caused by the mutual interference between multiple power supplies during the entry stage of wafer multi-anode electroplating in the prior art.

To achieve the above object and other relevant objects, the present invention provides a substrate electroplating apparatus, comprising at least two anodes, at least two power supplies, and at least one control switch; wherein the anodes are in one-to-one correspondence with the power supplies, each anode is connected to the positive electrode of the corresponding power supply, and the control switch is configured to connect the at least two anodes to the positive electrode of the same power supply when the control switch is energized.

Optionally, the anodes include a first anode and a second anode, the power supplies include a first power supply and a second power supply, and the control switch includes a first control switch; the positive electrode of the first power supply is connected to the first anode to form a first anode control circuit, the positive electrode of the second power supply is connected to the second anode to form a second anode control circuit; the first anode control circuit includes a first contact, the second anode control circuit includes a second contact, and the first control switch is connected between the first contact and the second contact.

Optionally, the anodes further include a third anode, the power supplies further include a third power supply, and the control switch further includes a second control switch; the positive electrode of the third power supply is connected to the third anode to form a third anode control circuit, the third anode control circuit includes a third contact, and the second control switch is connected between the second contact and the third contact.

Optionally, a diode is connected between each anode and the positive electrode of the corresponding power supply.

Optionally, the control switch is connected to the anodes through contacts, and each diode is arranged between the positive electrode of the corresponding power supply and the contact.

Optionally, the control switch includes a contactor.

The present invention also provides a substrate electroplating method applicable to the aforementioned substrate electroplating apparatus, comprising: during the entry stage of a substrate, energizing the control switch, activating one power supply, deactivating the remaining power supplies, and controlling all the anodes by the activated power supply; in the electroplating process stage of the substrate, de-energizing the control switch, activating the remaining power supplies, and controlling each anode by the corresponding power supply, respectively.

Optionally, the anodes include a first anode and a second anode, the power supplies include a first power supply and a second power supply, and the control switch includes a first control switch. The positive electrode of the first power supply is connected to the first anode to form a first anode control circuit, the positive electrode of the second power supply is connected to the second anode to form a second anode control circuit; the first anode control circuit includes a first contact, the second anode control circuit includes a second contact, and the first control switch is connected between the first contact and the second contact. The substrate electroplating method further comprises: during the entry stage of the substrate, energizing the first control switch, activating the first power supply, deactivating the second power supply, and the first anode and the second anode being connected to the first power supply and controlled by the first power supply; in the electroplating process stage of the substrate, de-energizing the first control switch, activating the second power supply, controlling the first anode by the first power supply, and controlling the second anode by the second power supply.

Optionally, the anodes further include a third anode, the power supplies further include a third power supply, and the control switch further includes a second control switch. The positive electrode of the third power supply is connected to the third anode to form a third anode control circuit, the third anode control circuit includes a third contact, and the second control switch is connected between the second contact and the third contact; the substrate electroplating method further comprises: during the entry stage of the substrate, energizing the first control switch and the second control switch, activating the first power supply, deactivating the second power supply and the third power supply, and the first anode, the second anode, and the third anode being

connected to the first power supply and controlled by the first power supply; in the electroplating process stage of the substrate, de-energizing the first control switch and the second control switch, activating the first power supply and the second power supply, controlling the first anode by the first power supply, controlling the second anode by the second power supply, and controlling the third anode by the third power supply.

As mentioned above, the present invention provides a substrate electroplating apparatus and a substrate electroplating method, which have the following beneficial effects:

1. By switching between a single power supply and multiple power supplies, the problem of current fluctuation caused by the mutual interference between multiple power supplies during the electroplating entry stage is effectively eliminated without affecting the electroplating effect in the multi-anode electroplating process stage.

2. The switching use of a single power supply and multiple power supplies brings more operability and stability to the programming of electroplating technical processes.

3. The transformation is carried out by using the original circuits of the machine, without the need to redesign and transform the electroplating chamber, and the cost is low.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present application are further described by the following embodiments and the accompanying drawings of the embodiments.

FIG. 1 is a schematic structure diagram of an exemplary substrate electroplating apparatus;

FIG. 2 is a schematic diagram of a current-time curve of an exemplary substrate electroplating apparatus;

FIGS. 3a and 3b are schematic structure diagrams of the substrate electroplating apparatus in Embodiment 1 of the present invention;

FIG. 3c is a schematic structure diagram of the substrate electroplating apparatus in another implementation mode of Embodiment 1 of the present invention;

FIG. 4 is a schematic diagram of the current-time curve of the substrate electroplating apparatus in Embodiment 1 of the present invention;

FIG. 5a is a schematic structure diagram of the substrate electroplating apparatus in Embodiment 2 of the present invention, wherein the control switches are shown in an off state;

FIG. 5b is a schematic structure diagram of the substrate electroplating apparatus in Embodiment 2 of the present invention, wherein the control switches are shown in an on state;

FIG. 6 is a schematic diagram of the current-time curve of the substrate electroplating apparatus in Embodiment 2 of the present invention;

FIG. 7 is a schematic flow diagram of the substrate electroplating method in Embodiment 3 of the present invention; and

FIG. 8 is a schematic flow diagram of the substrate electroplating method in Embodiment 4 of the present invention.

EMBODIMENTS OF THE INVENTION

The embodiments of the present invention are described below through specific examples, and those skilled in the art can easily understand other advantages and effects of the present invention from the content disclosed in this specification. The present invention can also be implemented or applied through other different specific embodiments, and various modifications or changes can be made to the details in this specification based on different viewpoints and applications without departing from the spirit of the present invention.

It should be noted that the accompanying drawings of the present disclosure only schematically illustrate the basic conception of the present invention, and although only the components related to the present invention are shown in the accompanying

drawings instead of being drawn according to the number, shape, and size of the components in actual implementation, the form, number, and proportion of each component in actual implementation can be arbitrarily changed, and the layout form of the components may also be more complex.

When the following description relates to the accompanying drawings, the same numerals in different accompanying drawings represent the same or similar elements unless otherwise indicated. The implementation modes described in the following exemplary embodiments do not represent all implementation modes consistent with the present invention. On the contrary, the implementation modes are only examples of devices consistent with some aspects of the present invention as detailed in the appended claims.

The terms used in the present disclosure are only for the purpose of describing specific embodiments, and are not intended to limit the present disclosure. The singular forms "a/an," "the," and "this" used in the present disclosure and the appended claims are also intended to include the plural forms unless the context clearly indicates otherwise. It should also be understood that the term "and/or" used herein refers to and includes any or all possible combinations of one or more of the associated listed items.

In the description of the present disclosure, unless otherwise specified and limited, it should be noted that the terms "installation," "interconnection," and "connection" should be understood in a broad sense, for example, the connections may denote mechanical or electrical connections, or internal communication between two elements. Such connections may be direct, or indirect through an intermediate medium, and those of ordinary skill in the art can understand the specific meanings of the above terms according to specific situations. It should be understood that although the terms "first," "second," and "third" may be used in the present disclosure to describe various information, the information should not be limited to these terms. These terms are only used to distinguish the same type of information from each other. In the description of the present disclosure, it should be understood that the terms such as "upper," "lower," "front," "rear," "left," "right," "vertical," "horizontal," "top," "bottom," "inner," and "outer" are used to indicate the orientation or positional relationship based on the orientation or positional relationship shown in the accompanying drawings, which are only for the convenience of describing the present invention and simplifying the

description, rather than indicating or implying that the referred apparatus or element must have a specific orientation, be constructed and operated in a specific orientation, and therefore cannot be understood as a limitation to the present invention.

Embodiment 1

According to FIGS. 1 and 2, FIG. 1 is a schematic structure diagram of an exemplary substrate electroplating apparatus; FIG. 2 is a schematic diagram of a current-time curve of an exemplary substrate electroplating apparatus, wherein the curve L10 shows a current-time curve of a first control loop, and the curve L20 shows a current-time curve of a second control loop.

As shown in FIG. 1, the substrate electroplating apparatus comprises an electroplating tank 10, the electroplating tank 10 includes a cathode chamber 101 located at the upper portion and an anode chamber 102 located at the lower portion, an electroplating solution is injected into the cathode chamber 101 and the anode chamber 102, and an ion-exchange membrane 30 is arranged between the cathode chamber 101 and the anode chamber 102. During an electroplating process treatment, a substrate 20 to be electroplated is arranged in the cathode chamber 101, and an anode P1 and an anode P2 are arranged in the anode chamber 102. It should be understood that the specific structures and operating processes of the electroplating tank 10 and the ion-exchange membrane 30 belong to the prior art, and the present invention does not make special limitations thereto, so no more details are given here.

Taking a dual-anode electroplating apparatus as an example, the anode P1 and the anode P2 correspond to two independently operating programmable power supplies (PPS for short). The positive electrode of a first power supply PPS1 is connected to the first anode P1, and the negative electrode of the first power supply PPS1 is connected to the substrate 20 to form the first control loop; the positive electrode of a second power supply PPS2 is connected to the second anode P2, and the negative electrode of the second power supply PPS2 is connected to the substrate 20 to form the second control loop.

With reference to FIG. 2, before the substrate 20 enters the electroplating solution, the first power supply PPS1 and the second power supply PPS2 are in a constant

voltage mode to provide a protection voltage for the substrate 20, so that an electrochemical reaction occurs when the substrate 20 is in contact with the electroplating solution, thereby preventing the electroplating solution from corroding a seed layer on the surface of the substrate 20. After the substrate 20 is in contact with the electroplating solution, both the first control loop and the second control loop are conductively connected. As shown in FIG. 2, both the current curves L10 and L20 rise from 0 ampere (A).

A trigger current is set in one of the control loops of the two anodes P1 and P2. In this example, the trigger current is set in the first control loop where the first anode P1 is located. As shown in FIG. 2, at time T1, after the current in the first control loop reaches a preset trigger current, the first power supply PPS1 and the second power supply PPS2 start mode switching, that is, switching from the constant voltage mode to the constant current mode. Due to the characteristics of the power supplies, the output current curves of the power supplies will drop briefly during the power supply mode switching process.

In an ideal state, after the power supplies are switched to the constant current mode, the current should increase to a preset value according to a preset curve, be maintained for a period of time, and then drop to a process current to enter a formal electroplating process stage. In this example, the preset current curve is a ramp type, that is, the current should increase linearly to a preset value after the power supplies are switched to the constant current mode. However, as shown in FIG. 2, after time T1, the current curves L10 and L20 do not increase linearly as expected after a brief drop, but show fluctuations as shown in an X area in FIG. 2.

To prevent the influence of unsafe and unstable factors such as current backflow, a protection diode usually needs to be connected between a positive electrode of a programmable power supply and an anode of the programmable power supply. According to FIG. 1, a positive electrode of a diode D1 is connected to the first power supply PPS1, and a negative electrode of the diode D1 is connected to the first anode P1; a positive electrode of a diode D2 is connected to the second power supply PPS2, and a negative electrode of the diode D2 is connected to the second anode P2. Due to the characteristics of the power supplies, when two or more power supplies start mode switching at the same time, complete synchronization cannot be achieved, and one

power supply will start switching first. With reference to FIG. 2, in this example, the first power supply PPS1 starts switching first, the diode D1 is conducted, the first control loop is conducted, and the current curve L10 rises linearly after a brief drop. At this time, the voltage at the negative electrode of the diode D2 is approximately equal to the voltage at the negative electrode of the diode D1, the diode D2 is in reverse cutoff, and the second control loop cannot be conducted. The voltage output by the second power supply PPS2 continues to rise until time T2, when the voltage output by the second power supply PPS2 makes the voltage drop at the two ends of the positive electrode and the negative electrode of the diode D2 greater than the conducting voltage of the diode D2, the diode D2 is conducted, the second control loop is conducted, and the current curve L20 starts to rise.

As shown in FIG. 2, in this process, at time T1, the first power supply PPS1 starts to switch to the constant current mode, the second control loop is conducted at time T2 after time T1, the conduction of the second control loop lags behind the conduction of the first control loop, resulting in the current curve L20 of the second control loop lagging behind the current curve L10 of the first control loop. And when the second control loop is conducted at time T2, it will in turn affect the current curve L10 of the first control loop, resulting in abnormal fluctuations as shown in the X area in FIG. 2.

If no protection diode is provided, first, a safety risk exists, second, mutual interference still exists between the first power supply PPS1 and the second power supply PPS2, because the first anode P1 and the second anode P2 are both immersed in the electroplating solution and share a cathode (the substrate 20), the first power supply PPS1 and the second power supply PPS2 are equivalently connected in parallel to act on the same load, the first control loop and the second control loop cannot be completely independent, and the voltages between the first control loop and the second control loop exhibit mutual influence. Especially during the entry stage, when the first power supply PPS1 and the second power supply PPS2 start to switch from the constant voltage mode to the constant current mode synchronously, mutual interference is inevitable and belongs to an uncontrollable factor, which will still cause undesired fluctuations in the current curve L10 and the current curve L20.

The duration of the substrate electroplating entry stage is usually at a millisecond level, so during the entry stage, the current fluctuation caused by the interference

between power supplies will have a great impact on the stability of the electroplating process.

To solve at least the above problems, one aspect of the present invention provides a substrate electroplating apparatus, comprising: at least two anodes, at least two power supplies, and at least one control switch; wherein each anode is connected to the positive electrode of the corresponding power supply, and the control switch is configured to connect the at least two anodes to the positive electrode of the same power supply when the control switch is energized.

According to FIGS. 3a and 3b, FIG. 3a is a schematic structure diagram of the substrate electroplating apparatus in Embodiment 1 of the present invention, wherein the control switch is in an off state; FIG. 3b is a schematic structure diagram of the substrate electroplating apparatus in Embodiment 1 of the present invention, wherein the control switch is in an on state. An electroplating tank 1 includes a cathode chamber 11 located at the upper portion and an anode chamber 12 located at the lower portion, an electroplating solution is injected into the cathode chamber 11 and the anode chamber 12, an ion-exchange membrane 3 is arranged between the cathode chamber 11 and the anode chamber 12, and during an electroplating process treatment, a substrate 2 to be electroplated is arranged in the cathode chamber 11.

In this embodiment, the anodes include two anodes, the first anode P1 and the second anode P2, the power supplies include two power supplies, the first power supply PPS1 and the second power supply PPS2, and the control switch includes a first control switch. The positive electrode of the first power supply PPS1 is connected to the first anode P1 to form the first anode control circuit, and the positive electrode of the second power supply PPS2 is connected to the second anode P2 to form the second anode control circuit. Negative electrodes of the first power supply PPS1 and the second power supply PPS2 are both electrically connected to the substrate 2 to form two current loops. The loop where the first anode control circuit is located is a first loop, and the loop where the second anode control circuit is located is a second loop; the first anode control circuit includes a first contact 4, the second anode control circuit includes a second contact 5, and the first control switch is connected between the first contact 4 and the second contact 5.

Preferably, in this embodiment, the first control switch is a contactor KM. It should be understood that in other possible embodiments, the first control switch may also be other types of switch devices, and those skilled in the art can make a reasonable selection according to the actual requirements of the circuit control.

Preferably, the power supplies are programmable power supplies, including but not limited to linear programmable power supplies, switching-mode programmable power supplies, and the like.

As shown in FIG. 3b, during the entry stage of the substrate 2, the contactor KM is energized, the second power supply PPS2 is deactivated, and the first anode P1 and the second anode P2 are connected in parallel to the positive electrode of the first power supply PPS1. That is, at this time, both the first anode P1 and the second anode P2 are controlled by the first power supply PPS1. As shown in FIG. 3a, in the electroplating process stage, after the substrate 2 completes entry, the contactor KM is de-energized, the second power supply PPS2 is activated, and the first anode P1 and the second anode P2 are respectively controlled by the first power supply PPS1 and the second power supply PPS2 independently. Since the electroplating process stage usually lasts for tens of seconds or hundreds of seconds, when each anode is controlled by each power supply independently during the process stage, even if mutual interference between power supplies occurs during the start-up stage, it will not have a substantial impact on the process stage.

With reference to FIG. 4, which is a schematic diagram of the current-time curve of the substrate electroplating apparatus in Embodiment 1 of the present invention, wherein the curve L1 shows a current-time curve of the first loop, the curve L2 shows a current-time curve of the second loop, and at time T3, the substrate 2 completes entry, the contactor KM is de-energized and the second power supply PPS2 is activated. It can be seen from FIG. 4 that during the period from 0 to T3, since both the first anode P1 and the second anode P2 are controlled by the first power supply PPS1, the curve L2 is always at the position of 0 ampere (A), and since only the first power supply PPS1 operates, no mutual interference between multiple power supplies exists, and the curve L1 will not have abnormal fluctuations caused by the power supply interference. The only fluctuation (Y area in FIG. 4) is a slight fluctuation generated during the process of the first power supply PPS1 switching from the constant voltage mode to

the constant current mode, and the slight fluctuation is determined by the operating characteristics of the power supplies, cannot be eliminated, and will not have a substantial impact on electroplating.

It should be noted that the positions of the first contact 4 and the second contact 5 shown in FIGS. 3a and 3b are exemplary. As shown in FIG. 3c, in another implementation mode of this embodiment, the first contact 4 may be located on the first anode P1, and the first contact 5 may be located on the second anode P2. Optionally, in other possible implementation modes of this embodiment, the first contact 4 may also be located on the positive electrode of the first power supply PPS1, and the first contact 5 may be located on the second anode P2. The first contact 4 is located on the first anode control circuit, and the second contact 5 is located on the second anode control circuit, the first power supply PPS1 and the first anode P1 are both parts of the first anode control circuit, and the second power supply PPS2 and the second anode P2 are both parts of the second anode control circuit, and those skilled in the art can adjust the positions of the first contact 4 and the second contact 5 according to the actual situation under the teaching of the present disclosure.

It should be understood that, as shown in FIGS. 3a, 3b, and 3c, in this embodiment, the diode D1 is connected between the positive electrode of the first power supply PPS1 and the first anode P1, and the diode D2 is connected between the positive electrode of the second power supply PPS2 and the second anode P2. Therefore, to not affect the protection effect of the diode D1 and the diode D2, the diode D1 and the diode D2 should be respectively arranged between the positive electrodes of the corresponding power supplies and the contacts, the contacts include the first contact 4 and the second contact 5, that is, the diode D1 should be arranged between the positive electrode of the first power supply PPS1 and the first contact 4, and the diode D2 should be arranged between the positive electrode of the second power supply PPS2 and the second contact 5. In other words, the first contact 4 should be between the negative electrode of the diode D1 and the first anode P1, and the second contact 5 should be between the negative electrode of the diode D2 and the second anode P2.

Embodiment 2

According to FIGS. 5a and 5b, FIG. 5a is a schematic structure diagram of the

substrate electroplating apparatus in Embodiment 2 of the present invention, wherein the control switches are shown in an off state; FIG. 5b is a schematic structure diagram of the substrate electroplating apparatus in Embodiment 2 of the present invention, wherein the control switches are shown in an on state.

Compared with Embodiment 1, this embodiment adds a third anode P3 and a third power supply PPS3, and adds a second control switch. The positive electrode of the third power supply PPS3 is connected to the third anode P3 to form a third anode control circuit, the third anode control circuit includes a third contact 6, the second control switch is connected between the second contact 5 and the third contact 6, and the negative electrode of the third power supply PPS3 is electrically connected to the substrate 2 to form a third loop where the third anode control circuit is located.

Similar to Embodiment 1, the control switches in this embodiment are selected as contactors. For the convenience of description, the first control switch between the first anode control circuit and the second anode control circuit is a contactor KM1, and the second control switch between the second anode control circuit and the third anode control circuit is a contactor KM2.

As shown in FIG. 5b, during the entry stage of the substrate 2, the contactor KM1 and the contactor KM2 are energized, the second power supply PPS2 and the third power supply PPS3 are deactivated, and the first anode P1, the second anode P2, and the third anode P3 are connected to the positive electrode of the first power supply PPS1. That is, at this time, the first anode P1, the second anode P2, and the third anode P3 are all controlled by the first power supply PPS1. As shown in FIG. 5a, during the electroplating process stage, after the substrate 2 completes entry, the contactor KM1 and the contactor KM2 are de-energized, the second power supply PPS2 and the third power supply PPS3 are activated, and the first anode P1, the second anode P2, and the third anode P3 are respectively controlled by the first power supply PPS1, the second power supply PPS2, and the third power supply PPS3 independently.

With reference to FIG. 6, which is a schematic diagram of the current-time curve of the substrate electroplating apparatus in Embodiment 2 of the present invention, the curve L21 shows a current-time curve of the first loop, the curve L22 shows a current-time curve of the second loop, and the curve L23 shows a current-time curve of the

third loop. At time T3, the substrate 2 completes entry, enters a formal electroplating process stage, the contactor KM1 and the contactor KM2 are de-energized, and the second power supply PPS2 and the third power supply PPS3 are activated.

It can be seen from FIG. 6 that during the period from 0 to T3, since the first anode P1, the second anode P2, and the third anode P3 are all controlled by the first power supply PPS1, the curve L22 and the curve L23 are always at the position of 0 ampere (A). And since only the first power supply PPS1 operates, no mutual interference between multiple power supplies exists, and the curve L21 will not have abnormal fluctuations caused by the power supply interference. The only fluctuation (Z area in FIG. 6) is a slight fluctuation generated during the process of the first power supply PPS1 switching from the constant voltage mode to the constant current mode, and the slight fluctuation is determined by the operating characteristics of the power supplies, cannot be eliminated, and will not have a substantial impact on electroplating.

It should be understood that Embodiment 1 and Embodiment 2 are only exemplary embodiments of the present invention, and in other possible embodiments, the number of anodes and power supplies may be more, and the number of control switches increases accordingly. The present invention does not limit the number and specific connection mode of the control switches, and the control switches should satisfy: when the control switches are energized, multiple anodes are connected in parallel to the positive electrode of the same power supply, so as to realize the control of multiple anodes by one power supply; when the control switches are de-energized, the independent control of each independent anode by each independent power supply is not affected.

Embodiment 3

Another aspect of the present invention also discloses a substrate electroplating method applicable to the aforementioned substrate electroplating apparatus. The substrate electroplating method comprises: during the entry stage of a substrate, energizing a control switch, activating one power supply, deactivating the remaining power supplies, and controlling the anodes by the activated power supply; in the electroplating process stage of the substrate, de-energizing the control switch, activating the remaining power supplies, and controlling each anode by the

corresponding anode, respectively.

Taking a substrate electroplating apparatus applicable to Embodiment 1 as an example, according to FIG. 7, during the entry stage of the substrate, the contactor KM is energized, the first power supply PPS1 is activated, the second power supply PPS2 is deactivated, and the first anode P1 and the second anode P2 are connected to the first power supply PPS1 and controlled by the first power supply PPS1; in the electroplating process stage of the substrate, the contactor KM is de-energized, the second power supply PPS2 is activated, the first anode P1 is controlled by the first power supply PPS1, and the second anode P2 is controlled by the second power supply PPS2.

Embodiment 4

Taking a substrate electroplating apparatus applicable to Embodiment 2 as an example, according to FIG. 8, during the entry stage of the substrate, the contactor KM1 and the contactor KM2 are energized, the first power supply PPS1 is activated, the second power supply PPS2 and the third power supply PPS3 are deactivated, and the first anode P1, the second anode P2, and the third anode P3 are connected to the first power supply PPS1 and controlled by the first power supply PPS1; in the electroplating process stage of the substrate, the contactor KM1 and the contactor KM2 are de-energized, the second power supply PPS2 and the third power supply PPS3 are activated, the first anode P1 is controlled by the first power supply PPS1, the second anode P2 is controlled by the second power supply PPS2, and the third anode P3 is controlled by the third power supply PPS3.

The above embodiments only exemplarily illustrate the principle and effects of the present invention, and are not intended to limit the present invention. Anyone skilled in the art can modify or change the above embodiments without departing from the spirit and scope of the present invention. Therefore, all equivalent modifications or changes completed by those with ordinary knowledge in the technical field without departing from the spirit and technical ideas disclosed in the present invention shall still be covered by the claims of the present invention.

What is claimed is:

1. A substrate electroplating apparatus, comprising:

at least two anodes, at least two power supplies, and at least one control switch;

wherein the anodes are in one-to-one correspondence with the power supplies, each anode is connected to the positive electrode of the corresponding power supply, and the control switch is configured to connect the at least two anodes to the positive electrode of the same power supply when the control switch is energized.

2. The substrate electroplating apparatus according to claim 1, wherein the anodes include a first anode and a second anode, the power supplies include a first power supply and a second power supply, and the control switch includes a first control switch;

the positive electrode of the first power supply is connected to the first anode to form a first anode control circuit, and the positive electrode of the second power supply is connected to the second anode to form a second anode control circuit;

the first anode control circuit includes a first contact, the second anode control circuit includes a second contact, and the first control switch is connected between the first contact and the second contact.

3. The substrate electroplating apparatus according to claim 2, wherein the anodes further include a third anode, the power supplies further include a third power supply, and the control switch further includes a second control switch;

the positive electrode of the third power supply is connected to the third anode to form a third anode control circuit;

the third anode control circuit includes a third contact, and the second control switch is connected between the second contact and the third contact.

4. The substrate electroplating apparatus according to claim 1, wherein a diode is connected between each anode and the positive electrode of the corresponding power supply.

5. The substrate electroplating apparatus according to claim 4, wherein the control switch is connected to the anodes through contacts, and each diode is arranged between the positive electrode of the corresponding power supply and the contact.

6. The substrate electroplating apparatus according to claim 1, wherein the control switch includes a contactor.

7. A substrate electroplating method applicable to the substrate electroplating apparatus according to claim 1, comprising:

during the entry stage of a substrate, energizing the control switch, activating one power supply, deactivating the remaining power supplies, and controlling all the anodes by the activated power supply;

in the electroplating process stage of the substrate, de-energizing the control switch, activating the remaining power supplies, and controlling each anode by the corresponding power supply, respectively.

8. The substrate electroplating method according to claim 7, wherein the anodes include a first anode and a second anode, the power supplies include a first power supply and a second power supply, and the control switch include a first control switch; the positive electrode of the first power supply is connected to the first anode to form a first anode control circuit, and the positive electrode of the second power supply is connected to the second anode to form a second anode control circuit; the first anode control circuit includes a first contact, the second anode control circuit includes a second contact, and the first control switch is connected between the first contact and the second contact;

the substrate electroplating method further comprises: during the entry stage of the substrate, energizing the first control switch, activating the first power supply, deactivating the second power supply, and the first anode and the second anode being connected to the first power supply and controlled by the first power supply;

in the electroplating process stage of the substrate, de-energizing the first control switch, activating the second power supply, controlling the first anode by the first

power supply, and controlling the second anode by the second power supply.

9. The substrate electroplating method according to claim 8, wherein the anodes further include a third anode, the power supplies further include a third power supply, and the control switch further includes a second control switch;

the positive electrode of the third power supply is connected to the third anode to form a third anode control circuit;

the third anode control circuit includes a third contact, and the second control switch is connected between the second contact and the third contact;

the substrate electroplating method further comprises: during the entry stage of the substrate, energizing the first control switch and the second control switch, activating the first power supply, deactivating the second power supply and the third power supply, and the first anode, the second anode, and the third anode being connected to the first power supply and controlled by the first power supply;

in the electroplating process stage of the substrate, de-energizing the first control switch and the second control switch, activating the first power supply and the second power supply, controlling the first anode by the first power supply, controlling the second anode by the second power supply, and controlling the third anode by the third power supply.