

ELECTROPLATING APPARATUS HAVING FUNCTION OF MONITORING
STATE OF ION-EXCHANGE MEMBRANE IN ELECTROPLATING
CHAMBER AND MONITORING METHOD

FIELD OF THE INVENTION

The present invention relates to the technical field of semiconductor manufacturing, and in particular relates to an electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber and a monitoring method.

BACKGROUND

Electroplating refers to a process in which cations of the plating metal in the electroplating solution are reduced on the surface of a workpiece to be plated to form a plating layer. In the ultra-large-scale integrated circuit interconnection technology, as the circuit integration degree continues to increase and the circuit size continues to decrease, the requirements for the quality of the plating layer also continue to increase.

Generally, an ion-exchange membrane is arranged in an electroplating chamber of an electroplating apparatus, and the electroplating chamber is divided into an independent cathode chamber and an independent anode chamber by the ion-exchange membrane. On one hand, the ion-exchange membrane can well separate the cathode electroplating solution from the anode electroplating solution, thereby avoiding cross-contamination between the cathode electroplating solution and the anode electroplating solution; on the other hand, metal ions to be plated can be supplemented to the cathode chamber through a concentration difference. However, in the existing electroplating apparatus, the ion-exchange membrane may have a problem with damage. Once the ion-exchange membrane is damaged, the ion-exchange membrane cannot effectively separate the cathode electroplating solution from the anode electroplating solution, thereby causing cross-contamination between the cathode electroplating solution and the anode electroplating solution and reducing the quality of the plating layer. In order to ensure the quality of the plating layer, it is necessary to ensure that the ion-exchange membrane is in a normal state. Therefore, an electroplating apparatus having the function of monitoring the state of the ion-exchange membrane in the electroplating

chamber is proposed.

SUMMARY

In order to timely detect whether the ion-exchange membrane is damaged, an electroplating apparatus having a function of monitoring the state of the ion-exchange membrane in the electroplating chamber is proposed to realize real-time monitoring of whether the state of the ion-exchange membrane is in a normal working state, which can improve the quality of the plating layer in the electroplating process.

In a first aspect, the present invention provides an electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber. The electroplating apparatus comprises:

an electroplating chamber, provided with the ion-exchange membrane inside, and the ion-exchange membrane dividing the electroplating chamber into a cathode chamber and an anode chamber;

an anode tank, configured to hold anode electroplating solution and connected to the anode chamber through a pipeline, so that the anode electroplating solution circulates between the anode chamber and the anode tank;

a cathode tank, configured to hold cathode electroplating solution and connected to the cathode chamber through a pipeline, so that the cathode electroplating solution circulates between the cathode chamber and the cathode tank;

a monitoring mechanism, configured to monitor at least one event information of the electroplating apparatus, and the event information being used to determine the state of the ion-exchange membrane.

According to a specific embodiment of the present application, the event information includes a change in pressure in the anode chamber, and the monitoring mechanism includes:

a pressure sensor, for sensing the pressure in the anode chamber and generating a pressure measurement signal;

a controller, for receiving the pressure measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the pressure measurement signal exceeds a preset pressure variation range.

According to a specific embodiment of the present application, the pressure sensor is arranged on the side wall of the anode chamber.

According to a specific embodiment of the present application, the event information includes a change in liquid level in the anode tank and/or the cathode tank, and the monitoring mechanism includes:

a continuous liquid level sensor, for sensing the liquid level in the anode tank and/or the cathode tank and generating a first liquid-level measurement signal;

a controller, for receiving the first liquid-level measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the change rate of the first liquid-level measurement signal exceeds a preset liquid level rate-of-change range.

According to a specific embodiment of the present application, the monitoring mechanism further includes:

a point-type liquid level sensor, in communication with the controller, configured to monitor the liquid level in the anode tank and/or the cathode tank and generate a second liquid-level measurement signal;

the controller is further configured to receive the second liquid-level measurement signal and determine that the state of the ion-exchange membrane is an abnormal state when the second liquid-level measurement signal exceeds a threshold value, wherein the threshold value includes a preset high liquid-level limit value and a preset low liquid-level limit value in the anode tank and/or the cathode tank.

According to a specific embodiment of the present application, the continuous liquid level sensor is arranged in the anode tank and/or the cathode tank, and the point-type liquid level sensor is arranged in the anode tank and/or the cathode tank.

According to a specific embodiment of the present application, the event information includes a change in the pH (refer to a measure of hydrogen-ion activity) value of the anode electroplating solution and/or the cathode electroplating solution, and the monitoring mechanism includes:

a pH sensor, for sensing the pH value of the anode electroplating solution and/or the cathode electroplating solution and generating a pH measurement signal;

a controller, for receiving the pH measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the pH measurement signal exceeds a preset pH variation range.

According to a specific embodiment of the present application, the pH sensor is arranged in the anode chamber and/or the cathode chamber.

According to a specific embodiment of the present application, the pH sensor is arranged on the pipeline through which the anode electroplating solution flows from the anode chamber to the anode tank, and/or on the pipeline through which the cathode electroplating solution flows from the cathode chamber to the cathode tank.

In a second aspect, the present invention provides a monitoring method for monitoring the state of an ion-exchange membrane in an electroplating chamber, the monitoring method monitors at least one event information of an electroplating apparatus, and the event information is used to determine the state of the ion-exchange membrane, wherein the event information includes one or any combination of a change in pressure in an anode chamber, a change in liquid level in an anode tank and/or a cathode tank, and a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution.

According to a specific embodiment of the present application, when the event information includes a change in pressure in the anode chamber, the monitoring method includes:

detecting the pressure in the anode chamber of the electroplating apparatus in real time and generating a pressure measurement signal;

monitoring the pressure measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the pressure measurement signal exceeds a preset pressure variation range.

According to a specific embodiment of the present application, when the event information includes a change in liquid level in the anode tank and/or the cathode tank, the monitoring method includes:

detecting the liquid level in the anode tank and/or the cathode tank connected to the electroplating chamber in real time and generating a first liquid-level measurement signal;

monitoring the first liquid-level measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the change rate of the first liquid-level measurement signal exceeds a preset liquid level rate-of-change range.

According to a specific embodiment of the present application, when the event information includes a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution, the monitoring method includes:

detecting the pH value of the anode electroplating solution and/or the cathode electroplating solution in fluid communication with the electroplating chamber in real time and generating a pH measurement signal;

monitoring the pH measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the pH measurement signal exceeds a preset pH variation range.

The present invention provides an electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber and a monitoring method. By arranging a monitoring mechanism to monitor various event information of the electroplating apparatus in real time, real-time monitoring of whether the state of the ion-exchange membrane is in a normal working state is realized, thereby preventing cross-contamination between the cathode electroplating solution and the anode electroplating solution, and ensuring the quality of the plating layer. Other features and advantages of the present invention will be set forth in the following

description, and some of the features and advantages will become obvious from the specification or be understood by implementing the present invention. The objectives and other advantages of the present invention can be realized and obtained through the structures specified in the specification and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 shows a schematic structural view of an electroplating apparatus according to Embodiment 1 of the present invention;

FIG. 2 shows a schematic structural view of an electroplating apparatus according to Embodiment 2 of the present invention;

FIG. 3 shows a schematic structural view of an electroplating apparatus according to Embodiment 3 of the present invention; and

FIG. 4 shows a schematic structural view of another electroplating apparatus according to an embodiment of the present invention.

PREFERRED EMBODIMENTS OF THE INVENTION

In order to clarify the objectives, technical solutions, and advantages of the embodiments of the present invention, the technical solutions in the embodiments of the present invention will be clearly and completely described below with reference to the drawings in the embodiments of the present invention. Obviously, the described embodiments are some of the embodiments of the present invention, but not all of the embodiments. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without making creative efforts shall fall within the protection scope of the present invention.

Embodiment 1

According to FIG. 1, FIG. 1 shows a schematic structural view of an electroplating

apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber according to an embodiment of the present invention. As shown in FIG. 1, the present invention provides an electroplating apparatus having the function of monitoring the state of an ion-exchange membrane in an electroplating chamber, and the electroplating apparatus comprises an electroplating chamber 100, an anode tank 200, a cathode tank 300, and a monitoring mechanism. The electroplating chamber includes an anode chamber 101, a cathode chamber 102 arranged on the top of the anode chamber 101, and an ion-exchange membrane 103 separating the anode chamber 101 from the cathode chamber 102. The compositions of the electroplating solutions in the anode chamber 101 and the cathode chamber 102 are slightly different. Specifically, the electroplating solution in the cathode chamber 102 usually contains additives, and the electroplating solution in the anode chamber 101 usually contains anode particles. The ion-exchange membrane 103 separates the cathode chamber 102 from the anode chamber 101, which can prevent the electroplating solutions in the two chambers from mixing, thereby avoiding the reaction between the cathode electroplating solution and the anode particles in the anode electroplating solution to generate pollutants and reduce the electroplating quality. The anode tank 200 is connected to the anode chamber 101 through a pipeline to form an anode circulation system, and the anode tank 200 is configured to hold anode electroplating solution; the cathode tank 300 is connected to the cathode chamber 102 through a pipeline to form a cathode circulation system, and the cathode tank 300 is configured to hold cathode electroplating solution; the monitoring mechanism is configured to monitor at least one event information of the electroplating apparatus when the electroplating apparatus is in the process of operation, and the event information is used to determine the state of the ion-exchange membrane 103.

Exemplarily, the monitoring mechanism includes a pressure sensor 401 and a controller. According to FIG. 1, FIG. 1 shows a schematic structural view of the electroplating apparatus according to Embodiment 1 of the present invention. As shown in FIG. 1, in the embodiment of the present invention, the monitoring mechanism includes: a pressure sensor 401, for sensing the pressure in the anode chamber 101 and generating a pressure measurement signal; and a controller, configured to receive the pressure measurement signal and determine that the state of the ion-exchange membrane is an abnormal state when the pressure measurement

signal exceeds a preset pressure variation range. During the actual installation of the pressure sensor 401, the pressure sensor 401 can be installed on the inner side wall or the outer side wall of the anode chamber 101 according to actual needs, provided that the pressure sensor 401 can monitor the pressure in the anode chamber 101.

Furthermore, the monitoring mechanism also includes an alarm (not shown in the figure) in communication with the controller. When the controller determines that the state of the ion-exchange membrane is an abnormal state, the controller sends an alarm command, and the alarm receives the alarm command, executes the alarm command, and issues an alarm.

The ion-exchange membrane 103 separates the anode electroplating solution from the cathode electroplating solution to prevent cross-contamination of the electroplating solutions, and at the same time makes the anode chamber 101 be in a state similar to a closed state. The anode chamber 101 is connected to the anode tank 200 through a pipeline to form an anode circulation system. During the process of operation, the amount of anode electroplating solution flowing from the anode tank 200 into the anode chamber 101 is the same as the amount of anode electroplating solution flowing back from the anode chamber 101 to the anode tank 200. Therefore, the anode circulation system is in a dynamic equilibrium process. At this time, the anode chamber 101 can be regarded as a closed chamber, and the pressure at all positions inside the anode chamber 101 is in a relatively constant state. When the pressure sensor 401 is used to measure the pressure in the anode chamber 101, the measured value of the pressure sensor 401 should be a relatively stable value or remain within a relatively stable pressure range. Once the ion-exchange membrane 103 is damaged, the electroplating solution in the anode chamber 101 will flow from the anode chamber 101 to the cathode chamber 102 through the damaged portion. At this time, the dynamic equilibrium of the anode circulation system will be broken, the value detected by the pressure sensor 401 will change, and because the electroplating solution in the anode chamber 101 continuously flows to the cathode chamber 102, the pressure in the anode chamber 101 will continuously decrease, and the value detected by the pressure sensor 401 will also continuously decrease. When the controller determines that the pressure value detected by the pressure sensor 401 exceeds a preset pressure variation range, the controller determines that the state of the ion-exchange membrane is an

abnormal state, sends an alarm command, and the alarm receives the alarm command and triggers an alarm. Exemplarily, the preset pressure variation range is 3 ± 0.2 psi. When the pressure value detected by the pressure sensor 401 is within the range of 3 ± 0.2 psi, the controller determines that the state of the ion-exchange membrane is a normal state and does not send an alarm command; when the detected pressure value is less than 2.8 psi, the controller determines that the state of the ion-exchange membrane is an abnormal state, sends an alarm command, and the alarm receives the alarm command and issues an alarm to remind staff to check and confirm the state of the ion-exchange membrane.

Embodiment 2

This embodiment provides an electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber. The structure of the electroplating apparatus is basically the same as the structure of the electroplating apparatus in Embodiment 1. The difference is that the event information monitored by the monitoring mechanism includes a change in liquid level in the anode tank and/or the cathode tank. For details, according to FIG. 2, FIG. 2 shows a schematic structural view of an electroplating apparatus according to an embodiment of the present invention. As shown in FIG. 2, the monitoring mechanism includes: a continuous liquid level sensor 4031, for sensing the liquid level in the anode tank 200 and/or the cathode tank 300 and generating a first liquid-level measurement signal; a controller, for receiving the first liquid-level measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the change rate of the first liquid-level measurement signal exceeds a preset liquid level rate-of-change range.

Furthermore, the monitoring mechanism also includes an alarm (not shown in the figure) in communication with the controller. When the controller determines that the state of the ion-exchange membrane is an abnormal state, the controller sends an alarm command, and the alarm receives the alarm command, executes the alarm command, and issues an alarm.

Furthermore, the continuous liquid level sensor 4031 can be installed in at least one of the anode tank 200 and the cathode tank 300. Considering that the volume of

the anode tank 200 is smaller than the volume of the cathode tank 300, the change in the liquid level in the anode tank 200 will be more obvious. Therefore, when a continuous liquid level sensor 4031 is selected to be installed in the anode tank 200 or the cathode tank 300, the continuous liquid level sensor 4031 can be preferentially installed in the anode tank 200 to monitor the liquid level in the anode tank 200.

Specifically, during the normal operation process, the electroplating solutions in the anode tank 200 and the cathode tank 300 are in a state of continuous consumption, but the consumption rate is relatively slow, so the supplement of the electroplating solutions is intermittent. During the operation process, the electroplating solutions in the anode tank 200 and the cathode tank 300 basically decrease at a constant change rate. Exemplarily, taking a certain copper electroplating process as an example, during an interval of electroplating solution supplement, the consumption rate of the electroplating solution in the anode tank 200 is 10 ml/h, and the consumption rate of the electroplating solution in the cathode tank 300 is 150 ml/h; since the pressure in the anode chamber 101 is greater than the pressure in the cathode chamber 102, once the ion-exchange membrane is damaged, part of the electroplating solution in the anode chamber 101 will flow to the cathode chamber 102 through the damaged portion, and then flow to the cathode tank 300 through the cathode chamber 102. Part of the electroplating solution in the anode tank 200 flows back to the anode tank 200 through the anode chamber 101, and the other part flows to the cathode tank 300. Finally, the electroplating solution in the anode tank 200 continuously decreases, and the decreasing speed of the electroplating solution becomes higher. Exemplarily, at this time, the consumption rate of the electroplating solution in the anode tank 300 is 50 ml/h. It should be understood that the greater the degree of damage to the ion-exchange membrane, the higher the decreasing rate of the electroplating solution in the anode tank 300. In this case, the consumption rate of the electroplating solution in the cathode tank 300 will decrease, or even the electroplating solution in the cathode tank 300 will increase instead of decreasing. Exemplarily, the consumption rate of the electroplating solution in the cathode tank 300 is 110 ml/h; based on this situation, when the continuous liquid level sensor 4031 detects the liquid level in the anode tank 200 and/or the cathode tank 300, the controller determines that the change rate of the detected first liquid-level measurement signal exceeds a preset liquid level change rate, that is, the change rate of the liquid level value of the electroplating solution in the anode tank

200 is changed from the preset liquid level value change rate of 10 ml/h to 50 ml/h, and/or the change rate of the liquid level value of the electroplating solution in the cathode tank 300 is changed from the preset liquid level value change rate of 150 ml/h to 120 ml/h, then the controller determines that the state of the ion-exchange membrane is an abnormal state, sends an alarm command, and the alarm receives the alarm command and triggers an alarm. It should be understood that when the liquid level in the anode tank 200 is detected, the liquid level continuously drops; when the liquid level in the cathode tank 300 is detected, the liquid level may continuously drop (but at a decreasing rate), or the liquid level may continuously rise. Therefore, it is possible to choose to simultaneously detect the change rates and the change trends of the liquid levels of the electroplating solutions in the anode tank 200 and the cathode tank 300. When the change rates of the liquid levels of the electroplating solutions in the anode tank 200 and the cathode tank 300 both exceed a preset liquid level rate-of-change range, with the liquid level in the anode tank 200 dropping and the liquid level in the cathode tank 300 either dropping at a decreasing rate or rising, it can be more accurately determined that the ion-exchange membrane is damaged. The controller sends an alarm command, and the alarm receives the alarm command and issues an alarm to remind staff to check and confirm the state of the ion-exchange membrane.

Furthermore, the high liquid-level limit value and the low liquid-level limit value are preset in the anode tank 200 and/or the cathode tank 300. The monitoring mechanism further includes: a point-type liquid level sensor 4032, in communication with the controller, configured to monitor the liquid level in the anode tank 200 and/or the cathode tank 300 and generate a second liquid-level measurement signal. The controller is further configured to receive the second liquid-level measurement signal and determine that the state of the ion-exchange membrane is an abnormal state when the second liquid-level measurement signal exceeds a threshold value, wherein the threshold value includes a preset high liquid-level limit value and a preset low liquid-level limit value in the anode tank and/or the cathode tank.

In this embodiment, a combination of the continuous liquid level sensor 4031 and the point-type liquid level sensor 4032 is used for monitoring. Both the continuous liquid level sensor 4031 and the point-type liquid level sensor 4032 are arranged in the anode tank 200 and/or the cathode tank 300. When the event information monitored

by the monitoring mechanism through the continuous liquid level sensor 4031 is a change in the liquid level, and the liquid level change rate exceeds a preset liquid level rate-of-change range, the controller sends an alarm command, and the alarm receives the alarm command, executes the alarm command, and triggers an alarm; and the point-type liquid level sensor 4032 monitors the limit liquid level in the anode tank 200 and/or the cathode tank 300. When it is detected that the second liquid-level measurement signal reaches the preset high liquid-level limit value or the preset low liquid-level limit value, the controller sends an alarm command, and the alarm receives the alarm command, executes the alarm command, and triggers an alarm, so as to further ensure the normal operation of the electroplating apparatus.

Embodiment 3

This embodiment provides an electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber. The structure of the electroplating apparatus is basically the same as the structure of the electroplating apparatus in Embodiment 2. The difference is that the event information monitored by the monitoring mechanism includes a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution. For details, as shown in FIG. 3, FIG. 3 shows a schematic structural view of an electroplating apparatus according to an embodiment of the present invention. As shown in FIG. 3, the monitoring mechanism includes: a pH sensor 402, for sensing the pH value of the anode electroplating solution and/or the cathode electroplating solution and generating a pH measurement signal; and a controller, configured to receive the pH measurement signal and determine that the state of the ion-exchange membrane is an abnormal state when the pH measurement signal exceeds a preset pH variation range.

Furthermore, the detection mechanism also includes an alarm (not shown in the figure) in communication with the controller. When the controller determines that the state of the ion-exchange membrane is an abnormal state, the controller sends an alarm command, and the alarm receives the alarm command, executes the alarm command, and issues an alarm.

Specifically, as shown in FIG. 3, during the electroplating process, both the anode chamber 101 and the cathode chamber 102 are filled with electroplating solutions, and

the electroplating solutions are both weakly acidic. Once the ion-exchange membrane 103 is damaged, the electroplating solution in the anode chamber 101 will flow into the cathode chamber 102 through the damaged portion. However, the cathode chamber 102 is in a relatively open state, and the excess electroplating solution will be directly discharged and flows back into the cathode tank 300. Part of the electroplating solution in the anode tank 200 flows back to the anode tank 200 through the anode chamber 101, and the other part flows to the cathode tank 300. Finally, the electroplating solution in the anode tank 200 continuously decreases, and the decreasing speed of the electroplating solution becomes higher. Once the electroplating solution in the anode tank 200 decreases too rapidly, in order to prevent the electroplating solution in the anode tank 200 from being exhausted (the electroplating apparatus will stop working once the electroplating solution in the anode tank is exhausted) and to ensure that the anode tank 200 has sufficient electroplating solution, deionized water will be preferentially supplemented into the anode tank 200 to maintain the operation of the electroplating apparatus. As a result, the pH value of the anode electroplating solution in the anode tank 200 will increase, so the pH value of the anode electroplating solution delivered into the anode chamber 101 will also increase, and the pH value in the anode chamber 101 will also increase. Since the electroplating solution in the anode chamber 101 is continuously delivered into the cathode chamber 102, the pH value in the cathode chamber 102 will also increase. Therefore, the pH values measured by pH sensors 402 arranged on the pipelines connecting the electroplating chamber 100 to the anode tank 200 and the cathode tank 300 will increase. Once the values detected by the pH sensors 402 increase, it means that the ion-exchange membrane 103 is damaged, and the alarm issues an alarm. Therefore, real-time monitoring of the pH values of the electroplating solutions in the electroplating chamber by using the pH sensors 402 can well monitor whether the ion-exchange membrane 103 is in a normal state.

It should be understood that the pH sensor 402 can be installed inside the anode tank 200 and/or the cathode tank 300, or on the pipeline through which the anode electroplating solution flows from the anode chamber 101 to the anode tank 200, and/or on the pipeline through which the cathode electroplating solution flows from the cathode chamber 102 to the cathode tank 300. For the convenience of installation, during the actual installation of the pH sensor 402, the pH sensor 402 is preferentially arranged on the pipeline through which the anode electroplating solution flows from

the anode chamber 101 to the anode tank 200, and/or on the pipeline through which the cathode electroplating solution flows from the cathode chamber 102 to the cathode tank 300 in the electroplating apparatus. During installation, the pH sensor 402 can be installed on at least one of the pipelines through which the anode electroplating solution flows from the anode chamber 101 to the anode tank 200 and the pipeline through which the cathode electroplating solution flows from the cathode chamber 102 to the cathode tank 300.

It should be noted that the technical features of the above-mentioned Embodiments 1 to 3 can be combined arbitrarily. For the sake of a concise description, not all possible combinations of the technical features in the above-mentioned embodiments are described. However, provided that no conflict arises during the combination of these technical features, the combination of these technical features should be regarded as the scope described in this specification. For example, as shown in FIG. 4, the pH sensor in the above-mentioned Embodiment 3 can also be combined with Embodiment 1 and/or Embodiment 2. It should be understood that when Embodiment 1 is combined with Embodiment 3, once the ion-exchange membrane is damaged, the first event that occurs is an instantaneous change in the pressure in the anode chamber, and the pressure sensor detects the change in the pressure in the anode chamber immediately. Therefore, the speed at which the pressure sensor in Embodiment 1 detects the change is higher than the speed at which the pH sensor in Embodiment 3 detects the change. During the determination process, the data in Embodiment 1 is first determined, and then the data in Embodiment 3 is further rechecked and determined; when Embodiment 2 is combined with Embodiment 3, since the supplement of the electroplating solutions to the cathode tank and the anode tank is intermittent during the normal operation process, and after it is found that the change rate of the first liquid-level measurement signal representing the liquid level in the anode tank and/or the cathode tank exceeds a preset liquid level rate-of-change range, in order to ensure the continuous operation of the system, the electroplating solutions are continuously supplemented. Therefore, the speed at which the continuous liquid level sensor in Embodiment 2 detects the change rate of the first liquid-level measurement signal is higher than the speed at which the pH sensor in Embodiment 3 detects the change in the pH value range. Therefore, when Embodiment 2 is combined with Embodiment 3, the first detected result is the change rate result of the first liquid-

level measurement signal, and then the result of the change in the pH value detected by the pH sensor. When Embodiments 1, 2, and 3 are combined to detect the state of the ion-exchange membrane, the result detected by the pressure sensor in Embodiment 1 is detected first, then the result of the change rate of the first liquid-level measurement signal detected by the continuous liquid level sensor in Embodiment 2 is detected, and then the result of the change in the pH value in Embodiment 3 is detected. During the operation process of the electroplating apparatus, once the monitoring mechanism detects that any of the above-mentioned event information is abnormal and issues an alarm to remind a staff to check, the staff needs to check other monitoring items. For example, when the pressure measurement signal of the pressure sensor is abnormal (exceed a preset pressure variation range) and the alarm issues an alarm, the staff needs to check whether there are abnormalities in the measurement signal of the pH sensor and the liquid level sensor while troubleshooting the pressure abnormality. Once the ion-exchange membrane is damaged, changes will occur in the liquid level of the anode tank, the liquid level of the cathode tank, the pH value of the anode chamber, the pH value of the cathode chamber, and the pressure in the anode chamber, etc. When the monitoring mechanism monitors that any one of the liquid level, pH value, and pressure gives an alarm, a control device will send an alarm command to prompt the staff to check and confirm the corresponding liquid level, pH value, and pressure of the electroplating apparatus.

Although the present invention has been described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that they can still modify the technical solutions recorded in the foregoing embodiments, or equivalently replace some of the technical features; and these modifications or replacements do not make the essence of the corresponding technical solutions deviate from the spirit and scope of the technical solutions of the embodiments of the present invention.

What is claimed is:

1. An electroplating apparatus having a function of monitoring the state of an ion-exchange membrane in an electroplating chamber, comprising:

an electroplating chamber, provided with the ion-exchange membrane inside, and the ion-exchange membrane dividing the electroplating chamber into a cathode chamber and an anode chamber;

an anode tank, configured to hold anode electroplating solution and connected to the anode chamber through a pipeline, so that the anode electroplating solution circulates between the anode chamber and the anode tank;

a cathode tank, configured to hold cathode electroplating solution and connected to the cathode chamber through a pipeline, so that the cathode electroplating solution circulates between the cathode chamber and the cathode tank;

a monitoring mechanism, configured to monitor at least one event information of the electroplating apparatus, and the event information being used to determine the state of the ion-exchange membrane.

2. The electroplating apparatus according to claim 1, wherein the event information includes a change in pressure in the anode chamber, and the monitoring mechanism includes:

a pressure sensor, for sensing the pressure in the anode chamber and generating a pressure measurement signal;

a controller, for receiving the pressure measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the pressure measurement signal exceeds a preset pressure variation range.

3. The electroplating apparatus according to claim 2, wherein the pressure sensor is arranged on the side wall of the anode chamber.

4. The electroplating apparatus according to claim 1, wherein the event

information includes a change in liquid level in the anode tank and/or the cathode tank, and the monitoring mechanism includes:

a continuous liquid level sensor, for sensing the liquid level in the anode tank and/or the cathode tank and generating a first liquid-level measurement signal;

a controller, for receiving the first liquid-level measurement signal and determining that the state of the ion-exchange membrane is an abnormal state when the change rate of the first liquid-level measurement signal exceeds a preset liquid level rate-of-change range.

5. The electroplating apparatus according to claim 4, the monitoring mechanism further including:

a point-type liquid level sensor, in communication with the controller, and configured to monitor the liquid level in the anode tank and/or the cathode tank and generate a second liquid-level measurement signal;

wherein the controller is further configured to receive the second liquid-level measurement signal and determine that the state of the ion-exchange membrane is an abnormal state when the second liquid-level measurement signal exceeds a threshold value, and the threshold value includes a preset high liquid-level limit value and a preset low liquid-level limit value in the anode tank and/or the cathode tank.

6. The electroplating apparatus according to claim 5, wherein the continuous liquid level sensor is arranged in the anode tank and/or the cathode tank; and the point-type liquid level sensor is arranged in the anode tank and/or the cathode tank.

7. The electroplating apparatus according to claim 1, wherein the event information includes a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution, and the monitoring mechanism includes:

a pH sensor, for sensing the pH value of the anode electroplating solution and/or the cathode electroplating solution and generating a pH measurement signal;

a controller, for receiving the pH measurement signal and determining that the

state of the ion-exchange membrane is an abnormal state when the pH measurement signal exceeds a preset pH variation range.

8. The electroplating apparatus according to claim 7, wherein the pH sensor is arranged in the anode chamber and/or the cathode chamber.

9. The electroplating apparatus according to claim 7, wherein the pH sensor is arranged on the pipeline through which the anode electroplating solution flows from the anode chamber to the anode tank, and/or on the pipeline through which the cathode electroplating solution flows from the cathode chamber to the cathode tank.

10. A monitoring method for monitoring the state of an ion-exchange membrane in an electroplating chamber, comprising:

monitoring at least one event information of an electroplating apparatus, the event information being used to determine the state of the ion-exchange membrane;

wherein the event information includes one or any combination of a change in pressure in an anode chamber, a change in liquid level in an anode tank and/or a cathode tank, and a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution.

11. The monitoring method according to claim 10, wherein, when the event information includes a change in pressure in the anode chamber, the monitoring method comprises:

detecting the pressure in the anode chamber of the electroplating apparatus in real time and generating a pressure measurement signal;

monitoring the pressure measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the pressure measurement signal exceeds a preset pressure variation range.

12. The monitoring method according to claim 10, wherein, when the event information includes a change in liquid level in the anode tank and/or the cathode tank, the monitoring method comprises:

detecting the liquid level in the anode tank and/or the cathode tank connected to the electroplating chamber in real time and generating a first liquid-level measurement signal;

monitoring the first liquid-level measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the change rate of the first liquid-level measurement signal exceeds a preset liquid level rate-of-change range.

13. The monitoring method according to claim 10, wherein, when the event information includes a change in the pH value of the anode electroplating solution and/or the cathode electroplating solution, the monitoring method comprises:

detecting the pH value of the anode electroplating solution and/or the cathode electroplating solution in fluid communication with the electroplating chamber in real time and generating a pH measurement signal;

monitoring the pH measurement signal, and determining that the state of the ion-exchange membrane is an abnormal state when the pH measurement signal exceeds a preset pH variation range.