

ELECTROPLATING APPARATUS

FIELD OF THE INVENTION

The present invention relates to the field of semiconductor manufacturing equipment, and in particular to an electroplating apparatus.

BACKGROUND

In the electroplating process, a metal block (used as an anode) and a substrate are immersed in an electroplating solution. An electric field is generated on the anode surface, and under the action of the electric field, metal is gradually deposited on the substrate surface. As shown in FIG. 1, in this electroplating apparatus, an anode chamber includes a low-level liquid inlet 100 and a high-level liquid outlet 200. During the electroplating process, the electroplating solution flows in through the liquid inlet 100 and spreads out in the gap between an anode plate and the bottom surface of the anode chamber; afterward, part of the electroplating solution flows upward through the central hole 300 of the anode plate, the rest electroplating solution flows upward along the surrounding wall surfaces, and finally, the two parts of the electroplating solution converge and flow toward the high-level liquid outlet 200.

However, the flow velocity in the chamber of this structure is gentle, and the flow field is uneven, especially the flow velocity of the electroplating solution on the anode surface is very low. Since a constant current mode is adopted during electroplating, when the electroplating amount is too large within a certain period of time, the oxides generated on the anode surface accumulate and cannot be washed away in time, resulting in an increase in the circuit impedance. As a result, the voltage of the entire circuit rises and an alarm is triggered, which even puts the electroplating apparatus on standby, and manual chamber disassembly and cleaning may be required, thus affecting the electroplating rate.

SUMMARY

The purpose of the present invention is to provide an electroplating apparatus, which is used to solve the problem in the prior art that the circuit impedance increases

due to the accumulation of oxides on the anode surface.

To achieve the above purpose and other related purposes, the present invention provides an electroplating apparatus, comprising:

a central flow tube, inserted through an anode; one end of the central flow tube being an anode electroplating solution inlet, and the other end extending out of the anode surface and being connected to a plurality of branch flow tubes extending toward the anode edge; each branch flow tube being provided with a plurality of spray holes;

wherein, the anode electroplating solution is supplied to the anode surface through the spray holes of the branch flow tubes.

Further, the plurality of spray holes on each branch flow tube face the anode surface.

Further, the opening directions of the plurality of spray holes on each branch flow tube are inclined relative to the vertical direction.

Further, the plurality of spray holes on each branch flow tube are divided into two groups, and the opening directions of the two groups of spray holes are different.

Further, the opening directions of the two groups of spray holes are symmetric with respect to the vertical direction.

Further, the opening directions of every two adjacent spray holes on each branch flow tube are different.

Further, the opening directions of every two adjacent spray holes are symmetric with respect to the vertical direction.

Further, the diameters or densities of the plurality of spray holes on each branch flow tube are the same.

Further, the diameters or densities of the plurality of spray holes on each branch flow tube are different.

Further, the diameters or densities of the plurality of spray holes on each branch flow tube gradually increase from the center to the edge along the radial direction of the anode.

Further, the end of each branch flow tube far away from the central flow tube is of a closed design.

Further, the electroplating apparatus also comprises:

an anode electroplating solution inlet, arranged at the bottom of an anode chamber;

an anode plate, covering the anode electroplating solution inlet and being used for supporting the anode; the anode plate being provided with a central hole, and the central hole being connected to the anode electroplating solution inlet.

Further, a sealing ring is arranged between the anode plate and the bottom surface of the anode chamber.

As mentioned above, the present invention provides an electroplating apparatus, which has the following beneficial effects: A central flow tube and branch flow tubes are added in an anode chamber to guide the anode electroplating solution to the anode surface, and the impact force of the solution is used to timely wash away the oxides generated on the anode surface, thereby ensuring that the circuit impedance remains unchanged and avoiding the increase of the circuit voltage. In addition, through the design of the plurality of branch flow tubes, the fluidity of the anode electroplating solution and the uniformity of the flow rate are enhanced.

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 view of an electroplating apparatus;

FIG. 2 shows a cross-sectional view of the electroplating apparatus of the present invention;

FIG. 3 shows another cross-sectional view of the electroplating apparatus of the present invention;

FIG. 4 shows an enlarged partial view of the circled part of the electroplating apparatus in FIG. 3;

FIG. 5 shows a schematic view of some components of the electroplating apparatus of the present invention.

PREFERRED EMBODIMENTS OF THE INVENTION

The implementation modes of the present invention can be described in detail through specific embodiments below. 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 specific embodiments, and various details in this specification can also be modified or changed based on different viewpoints and applications without departing from the spirit of the present invention.

It should be noted that the diagrams provided in this embodiment only schematically illustrate the basic concept of the present invention. Although the diagrams only show the components related to the present invention rather than being drawn according to the number, shape, and size of the components in actual implementation, the form, quantity, and proportion of each component in actual implementation can be changed arbitrarily, and the component layout form may also be more complex. In addition, the parts marked with the same reference numerals in multiple accompanying drawings represent the same or equivalent parts or components.

As shown in FIGS. 2 and 3, this embodiment proposes an electroplating apparatus, which comprises an electroplating chamber for containing electroplating solution. The interior of the electroplating chamber is divided into an anode chamber 11 and a cathode chamber 12, and the anode chamber 11 and the cathode chamber 12 are separated by a membrane 13 fixed to a membrane frame 14.

The membrane 13 is a cation-exchange membrane used for copper, nickel, and tin

electroplating. In addition, the membrane 13 can also be a proton exchange membrane or a common membrane covered with a fabric structure suitable for alloy electroplating. The membrane 13 is fixed to the membrane frame 14. The membrane frame 14 is a rigid perforated or mesh-like frame.

The anode chamber 11 contains an anode 111 and an anode plate 112, and the anode 111 is connected to an independently controlled power supply channel (not shown in the figure) through the anode plate 112. The electroplating current or voltage is independently applied to the anode 111 by the power supply channel. The power supply channel is connected to a power supply, and the power supply can be a direct-current power supply or a pulse power supply. The anode 111 is made of a soluble material, such as copper, nickel, or tin. The anode 111 can be a cylindrical body. As shown in FIG. 4, a liquid inlet 113 is arranged at the bottom of the anode chamber 11 to supply anode electroplating solution to the anode 111. At the same time, as shown in FIG. 3, a liquid outlet 114 is also arranged at the top of the side wall of the anode chamber 11 for draining the electroplating solution, decomposition products, and particles from the anode chamber 11.

As shown in FIG. 3, the membrane frame 14 is obliquely arranged between the anode chamber 11 and the cathode chamber 12, that is, the membrane frame 14 is not parallel to the bottom surface of the anode chamber 11 but tilted at an angle to the bottom surface. The liquid outlet 114 is arranged at the highest position of the side wall of the anode chamber 11 to facilitate the discharge of bubbles.

The anode plate 112 is arranged at the bottom of the anode chamber 11, and the anode 111 is arranged on the anode plate 112. Specifically, the anode 111 is fixed to the anode plate 112 through a fixing member 119. The anode plate 112 can be circular, a central hole 116 is arranged at the center of the anode plate 112, and the anode electroplating solution flows through the central hole 116. The anode plate 112 is made of an insoluble material, such as titanium or the metal oxide of titanium. As shown in FIG. 4, a sealing ring 115 is arranged between the anode plate 112 and the bottom surface of the anode chamber 11 to form a sealed contact between the anode plate 112 and the bottom surface of the anode chamber 11, so as to prevent the anode electroplating solution from flowing upward through the gap between the anode plate 112 and the surrounding of the anode chamber 11, thus guiding the anode electroplating

solution to the central hole 116 of the anode plate 112. In some embodiments, a sealing gasket can also be added between the anode plate 112 and the sealing ring 115, which is combined with the sealing ring 115 to achieve an improved sealing effect.

As shown in FIGS. 3 and 5, a central flow tube 117 is further arranged in the anode chamber 11, with one end being a first end 1171 and the other end being a second end 1172. Wherein, the first end 1171 serves as an anode electroplating solution inlet and is connected to the central hole 116 of the anode plate 112, and the second end 1172 is connected to a plurality of branch flow tubes 118 extending toward the edge. The central flow tube 117 is inserted through the anode 111, and the second end 1172 extends out of the anode surface 1111. The length of each branch flow tube 118 is less than the radius of the anode 111, and the end of the branch flow tubes 118 far away from the central flow tube 117 is of a closed design.

As shown in FIG. 5, the branch flow tubes 118 are circular tubes, and a plurality of spray holes 1181 are arranged on the side of each branch flow tube 118 facing the anode surface 1111 for supplying the anode electroplating solution to the anode surface 1111. In other embodiments, the branch flow tubes 118 can also be square tubes or tubes of other shapes. The diameters of the plurality of spray holes 1181 on each branch flow tube 118 can be the same or different. As the radius of the anode 111 increases, the area of the anode surface 1111 increases, and a higher flow rate is needed for washing. Therefore, in some embodiments, the diameter of the spray holes 1181 gradually increases from the center to the edge of the anode 111. Alternatively, the densities of the plurality of spray holes 1181 on each branch flow tube 118 can be the same or different. In some embodiments, the density of the spray holes 1181 gradually increases from the center to the edge of the anode 111. According to one embodiment, the opening direction of each spray hole 1181 is inclined relative to the vertical direction to prevent the anode electroplating solution from being sprayed to the same place and causing impact. The plurality of spray holes 1181 on each branch flow tube 118 can be divided into two groups. The opening directions of the two groups of spray holes 1181 are different. In some embodiments, the opening directions of the two groups of spray holes 1181 are symmetric with respect to the vertical direction. Alternatively, the opening directions of every two adjacent spray holes 1181 on each branch flow tube 118 are different. In some embodiments, the opening directions of

every two adjacent spray holes 1181 are symmetric with respect to the vertical direction. In some embodiments, as shown in FIG. 5, the second end 1172 of the central flow tube 117 is connected to four branch flow tubes 118 for uniformly distributing the flow rate, and the included angle between adjacent branch flow tubes 118 is 90 degrees. During the electroplating process, the anode 111 is continuously consumed, so that the distance from the anode surface 1111 to the branch flow tubes 118 gradually increases, and the impact force of the anode electroplating solution sprayed to the anode surface 1111 increases, thereby washing away the oxides accumulated on the anode surface 1111.

Through the design of the central flow tube 117 and the branch flow tubes 118, the anode electroplating solution is guided to the anode surface 1111, and the impact force of the solution is used to timely wash away the oxides generated on the anode surface 1111, thus ensuring that the circuit impedance remains basically unchanged, avoiding the electroplating apparatus standby caused by voltage rise and alarm, and improving the electroplating rate. In addition, a plurality of branch flow tubes 118 are arranged, which enhances the fluidity of the anode electroplating solution and the uniformity of the flow rate.

The above embodiments only exemplarily illustrate the principle and effects of the present invention, rather than being used to limit the present invention. Anyone skilled in the art can modify or change the above embodiments without violating the spirit and scope of the present invention. Therefore, all equivalent modifications or changes made 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. An electroplating apparatus, comprising an electroplating chamber, the electroplating chamber including an anode inside, comprising:

a central flow tube, inserted through the anode; one end of the central flow tube being an anode electroplating solution inlet, and the other end extending out of the anode surface and being connected to a plurality of branch flow tubes extending toward the anode edge; each branch flow tube being provided with a plurality of spray holes;

wherein, the anode electroplating solution is supplied to the anode surface through the spray holes of the branch flow tubes.

2. The electroplating apparatus according to claim 1, wherein the plurality of spray holes on each branch flow tube face the anode surface.

3. The electroplating apparatus according to claim 2, wherein the opening directions of the plurality of spray holes on each branch flow tube are inclined relative to the vertical direction.

4. The electroplating apparatus according to claim 3, wherein the plurality of spray holes on each branch flow tube are divided into two groups, and the opening directions of the two groups of spray holes are different.

5. The electroplating apparatus according to claim 4, wherein the opening directions of the two groups of spray holes are symmetric with respect to the vertical direction.

6. The electroplating apparatus according to claim 3, wherein the opening directions of every two adjacent spray holes on each branch flow tube are different.

7. The electroplating apparatus according to claim 6, wherein the opening directions of every two adjacent spray holes are symmetric with respect to the vertical direction.

8. The electroplating apparatus according to claim 1, wherein the diameters or

densities of the plurality of spray holes on each branch flow tube are the same.

9. The electroplating apparatus according to claim 1, wherein the diameters or densities of the plurality of spray holes on each branch flow tube are different.

10. The electroplating apparatus according to claim 9, wherein the diameters or densities of the plurality of spray holes on each branch flow tube gradually increase from the center to the edge along the radial direction of the anode.

11. The electroplating apparatus according to claim 1, wherein the end of each branch flow tube far away from the central flow tube is of a closed design.

12. The electroplating apparatus according to claim 1, further comprising:

an anode electroplating solution inlet, arranged at the bottom of an anode chamber;

an anode plate, covering the anode electroplating solution inlet and being used for supporting the anode; the anode plate being provided with a central hole, and the central hole being connected to the anode electroplating solution inlet.

13. The electroplating apparatus according to claim 12, wherein a sealing ring is arranged between the anode plate and the bottom surface of the anode chamber.