

LIQUID STORAGE DEVICE AND ELECTROPLATING APPARATUS

BACKGROUND OF THE INVENTION

[0001] Field of the Invention

[0002] The present invention relates to the field of semiconductor apparatus, particularly to a liquid storage device and electroplating apparatus.

[0003] The Related Art

[0004] A liquid storage tank is one of the most basic devices in electroplating apparatus, primarily used for storing solutions for zinc plating, copper plating, nickel plating, gold plating, etc. During electroplating, the flow rate and temperature of the solution are critical factors that affect the quality of the plating.

[0005] In existing single-chamber wafer electroplating apparatus, to save costs, there is often one liquid storage tank that supplies solution to different electroplating work chambers. The liquid storage tank provides the solution to different electroplating work chambers through different working cycle drain ports.

[0006] When a body of the liquid storage tank includes multiple working cycle drain ports, and the working cycle drain ports are located at different positions on the body of the liquid storage tank, the solution temperature at each working cycle drain port may vary due to uneven temperature distribution within the body of the liquid storage tank, leading to differences in the temperature of the solution entering different work chambers, thereby affecting the plating on the wafers. Moreover, if the temperature of the solution entering the work chamber is too low, it might lead to crystallization, contaminating the work chamber and possibly even the wafers.

SUMMARY

[0007] An objective of the present invention is to solve the problem in the existing technology that a single liquid storage tank supplies solution of varying temperatures to different work chambers. Therefore, this invention provides a liquid storage device and electroplating apparatus that have the advantage of supplying solution of nearly equal temperatures to different work chambers from a single liquid storage tank.

[0008] To solve the aforementioned issue, an embodiment of this invention provides a liquid storage device which comprises a tank body. The tank body comprises multiple working cycle drain ports for supplying solution to multiple work chambers and a thermal cycle liquid injection port for introducing heated solution into the tank body. The working cycle drain ports are located on opposite side walls of the tank body, and one of the side walls that connects these two side walls has the thermal cycle liquid injection port, which is located near or at the middle of the length of that side wall.

[0009] The liquid storage device also comprises a guide element, which is positioned in the tank body. The guide element is connected to the thermal cycle liquid injection port, the solution entering from the thermal cycle liquid injection port flows into the tank body via the guide element and flows to each of the working cycle drain ports.

[0010] Furthermore, another embodiment of this invention provides a liquid storage device of which tank body comprises a top and a bottom, and first, second, third, and fourth side walls that connect the top and bottom and are sequentially connected along the circumference of the tank body. The first side wall is opposite the third side wall, and the second side wall is opposite the fourth side wall;

[0011] the liquid storage device further comprises a cooling coil, which is located inside the tank body and fixed to the bottom, to facilitate heat exchange with the solution in the tank body.

[0012] Furthermore, another embodiment of this invention provides a liquid storage device of which both the first and third side walls are set with working cycle drain ports. The thermal cycle liquid injection port is located on the second side wall, near or at the middle of the length of the second side wall.

[0013] Furthermore, another embodiment of this invention provides a liquid storage device of which the thermal cycle liquid injection port is located near the middle of the length of the second side wall. An end of the guide element positioned away from the thermal cycle liquid injection port extends towards the fourth side wall to form an outlet for the solution to flow out.

[0014] Furthermore, another embodiment of this invention provides a liquid storage device of which the side wall of the guide element has at least one diverter port. The solution inside the guide element flows into the tank body through the diverter port.

[0015] Furthermore, another embodiment of this invention provides a liquid storage device of which the thermal cycle liquid injection port is located at the middle of the length of the second side wall, and the cooling coil is fixed at the central position of the bottom. An end of the guide element positioned away from the thermal cycle liquid injection port extends upward to form an upper outlet, which is located at the inner side of the cooling coil;

[0016] alternatively, an end of the guide element positioned away from the thermal cycle liquid injection port extends upward and downward to form an upper outlet and a lower outlet, and the upper outlet and the lower outlet are located at the inner side of the cooling coil.

[0017] Furthermore, another embodiment of this invention provides a liquid storage device of which both the first and third side walls have working cycle drain ports. The thermal cycle liquid injection port is located at the top and is positioned at the center of the top. An end of the guide element positioned away from the thermal cycle liquid injection port extends towards the bottom to form a lower outlet; wherein,

[0018] the cooling coil is fixed at the central position of the bottom, and the end of the guide element away from the thermal cycle liquid injection port is located at the inner side of the cooling coil.

[0019] Furthermore, another embodiment of this invention provides a liquid storage device of which the cooling coil comprises a coil body, a base, and multiple supports vertically arranged on the base. The supports are arranged separating from each other along the circumference of the base, and the supports are provided with multiple mounting holes spaced along the height of the supports. The coil body is spiral-shaped and is secured in these mounting holes.

[0020] Furthermore, another embodiment of this invention provides a liquid storage device of which each support is provided with multiple sets of mounting holes arranged side by side.

[0021] Furthermore, another embodiment of this invention provides an even-temperature liquid storage device, wherein the tank body comprises three working cycle drain ports, namely a first drain port, a second drain port, and a third drain port. The first and second drain ports are spaced apart and located on the first side wall, while the third drain port is located on the third side wall.

[0022] Furthermore, another embodiment of this invention provides a liquid storage device of which the tank body further comprises a working cycle injection port and a thermal cycle drain port. The working cycle injection port is used for allowing the solution flowing out from multiple work chambers to enter the tank body,

and the thermal cycle drain port is used for allowing the solution inside the tank body to flow out for heating; wherein,

[0023] the working cycle injection port is located at the top of the tank body, and the thermal cycle drain port is located at the bottom of the tank body.

[0024] Another embodiment of this invention provides an electroplating apparatus, which comprises a liquid storage device. This liquid storage device utilizes the aforementioned liquid storage device.

[0025] Furthermore, another embodiment of this invention provides an electroplating apparatus further comprising multiple work chambers for depositing metal layers on the surface of substrates and multiple working pumps. The multiple work chambers are correspondingly connected to the multiple working pumps, and these working pumps are correspondingly connected to multiple working cycle drain ports, allowing the solution in the tank body to be introduced into the corresponding work chambers.

[0026] Furthermore, another embodiment of this invention provides an electroplating apparatus, when the tank body comprises three working cycle drain ports, namely a first drain port, a second drain port and a third drain port, and the tank body further comprises a working cycle injection port and a thermal cycle drain port,

[0027] the multiple work chambers comprise a first work chamber, a second work chamber, and a third work chamber, and the multiple working pumps comprise a first working pump, a second working pump, and a third working pump;

[0028] the first working pump and the first work chamber are sequentially connected between the first drain port and the working cycle injection port, to form a first working cycle loop;

[0029] the second working pump and the second work chamber are sequentially connected between the second drain port and the working cycle injection port, to form a second working cycle loop;

[0030] the third working pump and the third work chamber are sequentially connected between the third drain port and the working cycle injection port, to form a third working cycle loop.

[0031] Furthermore, another embodiment of this invention provides an electroplating apparatus further comprising a thermal cycle pump and a heating device. The thermal cycle pump and the heating device are sequentially connected between the thermal cycle liquid injection port and the thermal cycle drain port, to form a thermal cycle loop.

[0032] As described above, the liquid storage device and the electroplating apparatus of this invention have the following advantages:

[0033] In a case that the tank body comprises multiple working cycle drain ports, by positioning the thermal cycle liquid injection port near or at the middle of the length of one side wall, and by setting the guide element at the thermal cycle liquid injection port, when the heated solution enters from the thermal cycle liquid injection port and flows out through the guide element, it can make the temperature and flow rate distribution of the solution in the tank body be uniform. The temperature and flow rate of the solution at each working cycle drain port tend to be equal, and the temperature and flow rate of the solution from each working cycle drain port to the corresponding work chamber also tend to be equal. This not only prevents any impact on the plating of substrates in the work chambers but also avoids inconsistencies in the temperature of the solution entering different work chambers, which may result in excessively low temperatures in one of the work chambers.

[0034] Other features and corresponding benefits of this invention are elucidated in the later part of the specification, and it should be understood that at least some benefits become apparent from the description in the specification of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] Fig. 1 is a perspective view of a liquid storage device provided by Embodiment 1 of this invention; wherein, a tank body of the liquid storage device is depicted in a transparent schematic to show the schematic structure of a guide element in the tank body;

[0036] Fig. 2 is another perspective view of the liquid storage device provided by Embodiment 1 of this invention;

[0037] Fig. 3 is yet another perspective view of the liquid storage device provided by Embodiment 1 of this invention;

[0038] Fig. 4 is a top view of the liquid storage device provided by Embodiment 1 of this invention;

[0039] Fig. 5 shows a partial schematic diagram of the guide element with one diverter port of the liquid storage device provided by Embodiment 1 of this invention;

[0040] Fig. 6 shows a partial schematic diagram of the guide element with four diverter ports of the liquid storage device provided by Embodiment 1 of this invention;

[0041] Fig. 7 is another perspective view of the liquid storage device provided by Embodiment 1 of this invention; wherein, the tank body is depicted in a transparent schematic to show the schematic structure of the guide element and a cooling coil in the tank body;

[0042] Fig. 8 is a perspective view of the cooling coil of the liquid storage device provided by Embodiment 1 of this invention;

[0043] Fig. 9 is a perspective view of a liquid storage device provided by Embodiment 2 of this invention; wherein, a tank body of the liquid storage device is depicted in a transparent schematic to show the schematic structure of a guide element and a coil body in the tank body;

[0044] Fig. 10 is a top view of the liquid storage device provided by Embodiment 2 of this invention;

[0045] Fig. 11 is a perspective view of a liquid storage device provided by Embodiment 3 of this invention; wherein, a tank body of the liquid storage device is depicted in a transparent schematic to show the schematic structure of a guide element and a coil body in the tank body;

[0046] Fig. 12 is a perspective view of a liquid storage device provided by Embodiment 4 of this invention; wherein, a tank body of the liquid storage device is depicted in a transparent schematic to show the schematic structure of a guide element and a coil body in the tank body; and

[0047] Fig. 13 is a schematic diagram of the working principle of an electroplating apparatus provided by Embodiment 5 of this invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0048] The embodiments of this invention are described below through specific examples, enabling those skilled in the art to easily understand other advantages and effects of this invention based on the disclosures of this specification. Although the description of this invention will be presented in conjunction with preferred embodiments, this does not imply that the features of the invention are limited to these embodiments. On the contrary, the purpose of introducing the invention in conjunction with embodiments is to cover other alternatives or modifications that may extend from the claims of this invention. To provide a deep understanding of this invention, the following description will comprise many specific details. It is also possible to implement this invention without these details. Moreover, to avoid confusing or obscuring the focus of this invention, some specific details will be omitted from the description. It should be noted that, unless there is a conflict, the

embodiments of this invention and the features within these embodiments can be combined with each other.

[0049] It should be noted that in this specification, similar labels and letters represent similar items in the diagrams below. Therefore, once an item is defined in one diagram, it is not necessary to further define or explain it in subsequent diagrams.

[0050] The technical solutions of this invention are clearly and completely described below in conjunction with the accompanying drawings. It is apparent that the described embodiments are part of the embodiments of this invention, not all of them. Based on the embodiments of this invention, all other embodiments obtained by those skilled in the art without engaging in creative endeavors fall within the scope of protection of this invention.

[0051] In the description of this invention, it should be noted that terms such as "center," "top," "bottom," "left," "right," "vertical," "horizontal," "inner," "outer," etc., indicating orientation or positional relationships, are based on the orientations or positions shown in the drawings. These terms are used only to facilitate the description of the invention and simplify the description, and are not meant to indicate or imply that the referred devices or elements must possess a specific orientation, be constructed, and operate in a specific orientation, hence they should not be considered as limiting the invention. Furthermore, the terms "first," "second," "third," etc., are used for descriptive purposes only and should not be construed as indicating or implying any relative importance.

[0052] In the description of this invention, it should be further noted that unless otherwise explicitly specified and limited, terms like "mounted," "connected," and "linked" should be understood broadly. For example, they could be fixedly connected, detachably connected, or integrally connected; they could be mechanically connected or electrically connected; they could be directly connected or indirectly connected through an intermediary, or they could involve intercommunication within two

components. Those skilled in the art can understand the specific meanings of these terms in this invention based on specific circumstances.

[0053] To make the objectives, technical solutions, and advantages of this invention clearer, the embodiments of this invention will be described in further detail with reference to the accompanying drawings.

[0054] Embodiment 1

[0055] Referring to Fig. 1, embodiment 1 of this invention provides a liquid storage device 10, which comprises a tank body 100. The tank body 100 includes a working cycle injection port 110 and multiple working cycle drain ports. The multiple working cycle drain ports are used to supply solution to multiple work chambers (as shown in Fig. 13, the first work chamber 310, the second work chamber 320, and the third work chamber 330), which are typically used for electroplating substrates. The working cycle injection port 110 allows the solution that flows out from the multiple work chambers to be recirculated back into the tank body 100. In this embodiment, the solution in the tank body 100 can be used for gold plating, zinc plating, copper plating, or nickel plating, etc.

[0056] The tank body 100 further includes a thermal cycle liquid injection port 130 and a thermal cycle drain port 140. The solution in the tank body 100 flows out from the thermal cycle drain port 140, and is heated, and then is reintroduced into the tank body 100 through the thermal cycle liquid injection port 130.

[0057] Working cycle drain ports are provided on two opposing side walls of the tank body 100 to fully utilize the spatial positioning of the tank body 100. A thermal cycle liquid injection port 130 is located on one side wall that connects these two opposing side walls, and the thermal cycle liquid injection port 130 is positioned near or at the middle of the length of that side wall.

[0058] The liquid storage device 10 also comprises a guide element 200, which is located inside the tank body 100. The guide element 200 is connected to the thermal

cycle liquid injection port 130. The solution entering from the thermal cycle liquid injection port 130 flows through the guide element 200 into the tank body 100, and then flows to each of the working cycle drain ports. The guide element 200 is hollow, featuring a channel that allows the solution to flow through.

[0059] In this embodiment, in a case that one tank body 100 comprises multiple working cycle drain ports, the heated solution enters from the thermal cycle liquid injection port 130 and flows into the tank body 100 through the guide element 200. This configuration achieves uniform temperature distribution within the tank body 100, making the temperature of the solution at each working cycle drain port tend to be equal. Therefore, the temperature of the solution entering different work chambers from these drain ports will also tend to be the same, thus preventing the variations in solution temperature from affecting the plating on the substrates. Moreover, since the solution temperature within the tank body 100 is uniformly distributed, and the temperature at each working cycle drain port tends to be equal, it avoids issues such as the solution temperature being too low when entering a particular work chamber to cause crystallization and potentially contaminate the work chamber and the substrates. Therefore, this liquid storage device 10 has the advantage of making the temperature of the solution entering different work chambers tend to be equal.

[0060] Additionally, by positioning the thermal cycle liquid injection port 130 at the middle of the side wall connected to the opposing side walls, it also ensures uniform distribution of the flow rate of the solution within the tank body 100. This uniformity makes the flow rate of the solution at each working cycle drain port tend to be equal, avoiding a situation where the flow rate at a working cycle drain port on one side of the tank body 100 is higher than that on the other side, which could affect the quality of the electroplating. Therefore, this liquid storage device 10 not only has the advantage of making the temperature of the solution entering different work chambers

tend to be equal, but also ensures that the flow rate of the solution entering different work chambers tends to be equal.

[0061] In conjunction with Figs. 1 to 3, the tank body 100 comprises an opposing top 105 and bottom, as well as a first side wall 101, a second side wall 102, a third side wall 103, and a fourth side wall 104, which connect the top 105 and the bottom and are sequentially connected along the circumference of the tank body 100. The first side wall 101 is opposite the third side wall 103, and the second side wall 102 is opposite the fourth side wall 104. In this embodiment, the first side wall 101 and the third side wall 103 are opposite each other in the width direction W of the tank body 100, while the second side wall 102 and the fourth side wall 104 are opposite each other in the length direction L of the tank body 100.

[0062] The working cycle injection port 110 is located at the top 105 of the tank body 100, and the thermal cycle drain port 140 is located at the bottom of the tank body 100.

[0063] The tank body 100 comprises three working cycle drain ports, which are respectively the first drain port 121, the second drain port 122, and the third drain port 123. The first drain port 121 and the second drain port 122 are spaced apart on the first side wall 101, and the third drain port 123 is located on the third side wall 103.

[0064] The thermal cycle liquid injection port 130 is located on the second side wall 102, near the middle of its length, and an end of the guide element 200 away from the thermal cycle liquid injection port 130 extends towards the fourth side wall 104 to form an outlet 202 for the solution to flow out. The length direction of the second side wall 102 is also the length direction L of the tank body 100. The first drain port 121, the second drain port 122, the third drain port 123, and the thermal cycle liquid injection port 130 are all located near the bottom of the tank body 100.

[0065] In this embodiment, the tank body 100, which comprises three working cycle drain ports, can meet the demands of three work chambers. Considering the

spatial factor of the tank body 100, the third drain port 123 is positioned opposite the first drain port 121 and the second drain port 122, that is, the third drain port 123 is located on the third side wall 103. The heated solution enters the tank body 100 from the thermal cycle liquid injection port 130 and the guide element 200, flowing towards the first drain port 121, the second drain port 122, and the third drain port 123. This arrangement ensures that the temperature and flow rate of the solution at the three working cycle drain ports tend to be equal. This setup aims to achieve stable flow and temperature control for supplying solution to three work chambers using a single liquid storage device 10, ultimately fulfilling the purpose of stable solution supply for three work chambers.

[0066] Additionally, the hollow guide element 200 has a circular cross-section. In alternative embodiments, the cross-section of the hollow guide element 200 could also be square, triangular, diamond-shaped, fan-shaped, or a polygon with more than four sides.

[0067] Referring to Fig. 4, in this embodiment, the projection of an end of the guide element 200 away from the thermal cycle liquid injection port 130 on the first side wall 101 is located between the first drain port 121 and the second drain port 122, ensuring that the temperature and flow rate of the solution on both sides of the guide element 200 are similar, thereby making the temperature and flow rate of the solution at the first drain port 121, the second drain port 122, and the third drain port 123 tend to be equal.

[0068] Furthermore, along the direction from the second side wall 102 to the fourth side wall 104, the first drain port 121 and the second drain port 122 are spaced sequentially. The distance between the third drain port 123 and the second side wall 102 is less than or equal to the distance between the second drain port 122 and the second side wall 102. This means that the first drain port 121 is closer to the second side wall 102 compared to the second drain port 122.

[0069] Due to the possibility that the heated solution may cause the solution temperature near the fourth side wall 104 to be higher than the solution temperature near the second side wall 102 after flowing out of the guide element 200, by setting the distance between the third drain port 123 and the second side wall 102 to be less than or equal to the distance between the second drain port 122 and the second side wall 102 can avoid inconsistencies in the solution temperature at the third drain port 123 and the second drain port 122.

[0070] When there are no diverter ports 210 on the side wall of the guide element 200, all the solution from the thermal cycle liquid injection port 130 enters the tank body 100 through the outlet 202 of the guide element 200.

[0071] Optionally, the side wall of the guide element 200 may have at least one diverter port 210, through which the solution inside the guide element 200 enters the tank body 100. This means that the solution in the guide element 200 enters the tank body 100 both through the outlet 202 of the guide element 200 and through the diverter port 210.

[0072] Optionally, the side wall of the guide element 200 has four diverter ports 210, which are evenly arranged. The solution inside the guide element 200 enters the tank body 100 through the four diverter ports 210. The four diverter ports 210 can be positioned on the same side of the guide element 200 or can be staggered on different sides of the guide element 200.

[0073] In summary, the liquid storage device 10 provided by this invention can choose whether to set up a diverter port 210 and the number of diverter ports 210 on the side wall of the guide element 200 according to actual needs. The size of the diverter port 210 can be set according to actual requirements.

[0074] Furthermore, the solution entering from the thermal cycle liquid injection port 130 serves as the supply solution. The supply temperature of the supply solution is variable; for instance, the temperature of the supply solution after initial

heating and the thermal cycle temperature during stable operation may differ. Therefore, in this embodiment, the value of the supply temperature is not specified and will be determined based on actual needs.

[0075] In conjunction with Figs. 4, 7, and 8, the liquid storage device 10 also comprises a cooling coil 700, which is located in the tank body 100 and fixed at the bottom. The cooling coil 700 is used to cool the solution entering the tank body 100, acting to balance the solution temperature.

[0076] The liquid storage device 10 also comprises a temperature sensor 800, which is installed at the top 105 of the tank body 100 to detect the temperature of the solution in the tank body 100. The installation location, numbers, and the type of temperature sensor 800 can be determined based on specific practical situations, and this embodiment does not specify any limitations. The cooling coil 700 comprises a coil body 710, a base 720, and multiple supports 730 set vertically on the base 720. These supports 730 are spaced around the circumference of the base 720, and along the height direction H of the supports 730, multiple mounting holes 731 are provided on the supports 730. The coil body 710 is spiral-shaped and is secured within these multiple mounting holes 731. In this embodiment, the coil body 710 is set vertically, the number of mounting holes 731 matches the number of coils of the coil body 710, and the centers of the mounting holes 731 on each support 730 are aligned in a straight line.

[0077] Referring to Fig. 8, each support 730 is provided with multiple sets of mounting holes 731 arranged side by side to secure coil bodies 710 of different diameters. In this embodiment, there are four supports 730, each support 730 has two sets of multiple mounting holes 731.

[0078] Additionally, between two adjacent supports 730, there are crossbeams 750, and between any two crossbeams 750, a support beam can be bridged to ensure that all four supports 730 are set vertically and to also provide reinforcement.

[0079] Embodiment 2

[0080] In conjunction with Figs. 9 and 10, Fig. 9 and 10 respectively show only the coil body 710 of the cooling coil (refer to Fig. 8 for the cooling coil 700). The liquid storage device 10 provided by Embodiment 2 of this invention, compared to the liquid storage device 10 provided by Embodiment 1, differs in that the thermal cycle liquid injection port 130 is located at the middle position of the length of the second side wall 102, and the cooling coil is fixed at the central position of the bottom.

[0081] An end of a guide element 200A away from the thermal cycle liquid injection port 130 extends upward to form an upper outlet 203, which is located on the inner side of the coil body 710 of the cooling coil, so that the heated solution firstly enters the inner side of the coil body 710 after flowing out from the upper outlet 203, to better balance the temperature of the solution.

[0082] In this embodiment, the thermal cycle liquid injection port 130 is located at the middle of the length of the second side wall 102, and the cooling coil is fixed at the central position of the bottom, and the upper outlet 203 of the guide element 200A is positioned at the inner side of the coil body 710, to achieve the goal of making the distances from the upper outlet 203 of the guide element 200A to the first drain port 121, the second drain port 122, and the third drain port 123 approximately equal. This configuration achieves the effect of making the temperature and flow rate of the solution at the first drain port 121, the second drain port 122, and the third drain port 123 tend to be equal.

[0083] Embodiment 3

[0084] Referring to Fig. 11, which only shows the coil body 710 of the cooling coil (refer to Fig. 8 for the cooling coil 700). The liquid storage device 10 provided by Embodiment 3 of this invention, compared to the liquid storage device 10 provided by Embodiment 2, differs in that an end of a guide element 200B away from the thermal cycle liquid injection port 130 extends respectively upwards and downwards to form

an upper outlet 204 and a lower outlet 205, making the guide element 200B be "T"-shaped.

[0085] The heated solution enters the guide element 200B through the thermal cycle liquid injection port 130 and flows out from both the upper outlet 204 and the lower outlet 205, and exchanges heat with the coil body 710, so as to better balance the temperature of the solution. Simultaneously, it ensures that the temperature and flow rate of the solution at the first drain port 121, the second drain port 122, and the third drain port 123 tend to be equal.

[0086] Embodiment 4

[0087] Referring to Fig. 12, which only shows the coil body 710 of the cooling coil (refer to Fig. 8 for the cooling coil 700). The liquid storage device 10 provided by Embodiment 4 of this invention, compared to the liquid storage device 10 provided by Embodiment 1, differs in that the thermal cycle liquid injection port 130 is located at the top 105, specifically at the center of the top 105. An end of a guide element 200C away from the thermal cycle liquid injection port 130 extends towards the bottom to form a lower outlet 206.

[0088] The cooling coil is fixed at the central position of the bottom, and the lower outlet 206 of the guide element 200C is located at the inner side of the coil body 710 of the cooling coil. The heated solution enters the guide element 200C from the thermal cycle liquid injection port 130 at the center of the top 105 and flows out from the lower outlet 206, and exchanges heat with the coil body 710, so as to better balances the temperature of the solution while ensuring that the temperature and flow rate of the solution at the first drain port 121, the second drain port 122, and the third drain port 123 tend to be equal.

[0089] Embodiment 5

[0090] Referring to Fig. 13, an electroplating apparatus 1000 provided by Embodiment 5 of this invention uses the liquid storage device 10 of Embodiment 1. It

should be noted that the positions of the thermal cycle liquid injection port 130, the first drain port 121, the second drain port 122, and the third drain port 123 shown in Fig. 13 are illustrative and do not represent their actual locations.

[0091] The electroplating apparatus 1000 also comprises multiple work chambers used for depositing metal layers on the surface of substrates and multiple working pumps. The multiple work chambers are connected to corresponding working pumps, and the multiple working pumps are connected to multiple working cycle drain ports, allowing the solution in the tank body 100 to be introduced into the corresponding work chambers, which are used for electroplating substrates. The working cycle injection port 110 is connected to the multiple work chambers so that after electroplating is completed on the substrates, the solution drained from the multiple work chambers can enter the tank body 100 through the working cycle injection port 110.

[0092] In this embodiment, by optimizing the design of the thermal cycle liquid injection port 130 and the multiple working cycle drain ports in the liquid storage device of Embodiment 1, a more uniform distribution of temperature and flow rate of the solution in the tank body 100 is achieved. Therefore, the temperature and flow rate of the solution entering the corresponding work chambers from the corresponding working cycle drain ports tend to be equal, enabling the electroplating apparatus 1000 with the liquid storage device 10 to provide stable flow and temperature solution for multiple work chambers simultaneously using a single liquid storage device 10. Moreover, due to the uniform temperature distribution of the solution in the tank body 100, the temperatures at the various working cycle drain ports tend to be equal, preventing the occurrence of crystallization due to excessively low temperatures of the solution entering any work chamber of the electroplating apparatus 1000.

[0093] In Embodiment 1, the tank body 100 of the liquid storage device 10 comprises three working cycle drain ports. Correspondingly, the multiple work

chambers of the electroplating apparatus 1000 comprise a first work chamber 310, a second work chamber 320, and a third work chamber 330. The multiple working pumps comprise a first working pump 410, a second working pump 420, and a third working pump 430.

[0094] The first working pump 410 and the first work chamber 310 are sequentially connected between the first drain port 121 and the working cycle injection port 110, forming the first working cycle loop. The liquid storage device 10 supplies solution to the first work chamber 310 through the first working pump 410.

[0095] The second working pump 420 and the second work chamber 320 are sequentially connected between the second drain port 122 and the working cycle injection port 110, forming the second working cycle loop. The liquid storage device 10 supplies solution to the second work chamber 320 through the second working pump 420.

[0096] The third working pump 430 and the third work chamber 330 are sequentially connected between the third drain port 123 and the working cycle injection port 110, forming the third working cycle loop. The liquid storage device 10 supplies solution to the third work chamber 330 through the third working pump 430. In this embodiment, there is one working cycle injection port 110, and the main pipeline connected to the working cycle injection port 110 has three branch pipelines, each connecting to a work chamber.

[0097] In this embodiment, the liquid storage device 10 ensures uniform temperature distribution of the solution in the tank body 100. The temperatures and flow rates of the solution at the various working cycle drain ports tend to be equal, thus the temperatures and flow rates of the solution in the multiple working pumps of the electroplating apparatus 1000 also tend to be equal, therefore, the temperatures and flow rates of the solution entering the different work chambers tend to be equal.

[0098] The electroplating apparatus 1000 also comprises a heating device 500 and a thermal cycle pump 600. The thermal cycle pump 600 and the heating device 500 are sequentially connected between the thermal cycle liquid injection port 130 and the thermal cycle drain port 140 to form a thermal cycle loop. The thermal cycle pump 600 extracts cooler solution from the tank body 100 through the thermal cycle drain port 140. This cooler solution, is pumped back into the tank body 100 through the thermal cycle liquid injection port 130 after being heated by the external heating device 500.

[0099] It should be noted that the embodiments described above are intended only to illustrate the technical solutions of this invention and not to limit them. Although this invention has been described in detail with reference to the aforementioned embodiments, those skilled in the art should understand that they can still modify the described embodiments or equivalently replace some or all of the technical features therein. These modifications or replacements do not deviate from the essence of the technical solutions of the embodiments of this invention.

What is claimed is:

1. A liquid storage device, comprising a tank body, the tank body including multiple working cycle drain ports for supplying solution to multiple work chambers and a thermal cycle liquid injection port for introducing heated solution into the tank body, the working cycle drain ports being located on opposite side walls of the tank body, and a side wall connecting the two side walls is provided with the thermal cycle liquid injection port, and the thermal cycle liquid injection port being located near or at the middle of the length of the one side wall;

the liquid storage device also comprising a guide element being positioned in the tank body, the guide element being connected to the thermal cycle liquid injection port, the solution entering from the thermal cycle liquid injection port flowing into the tank body via the guide element, and flowing to each of the working cycle drain ports.

2. The liquid storage device as claimed in claim 1, wherein the tank body comprises a top and a bottom, and first, second, third, and fourth side walls that connect the top and the bottom and are sequentially connected along the circumference of the tank body, the first side wall is opposite the third side wall, and the second side wall is opposite the fourth side wall;

the liquid storage device further comprises a cooling coil, which is located inside the tank body and fixed to the bottom, to facilitate heat exchange with the solution in the tank body.

3. The liquid storage device as claimed in claim 2, wherein the first and third side walls are set with working cycle drain ports, and the thermal cycle liquid injection port is located on the second side wall, near or at the middle of the length of the second side wall.

4. The liquid storage device as claimed in claim 3, wherein the thermal cycle liquid injection port is near the middle of the length of the second side wall, and an end of the guide element away from the thermal cycle liquid injection port extends towards the fourth side wall to form an outlet for the solution to flow out.

5. The liquid storage device as claimed in claim 4, wherein the side wall of the guide element has at least one diverter port, through which the solution inside the guide element enters the tank body.

6. The liquid storage device as claimed in claim 3, wherein the thermal cycle liquid injection port is located at the middle of the length of the second side wall, and the cooling coil is fixed at the central position of the bottom;

an end of the guide element away from the thermal cycle liquid injection port extends upwards to form an upper outlet, and the upper outlet is located at the inner side of the cooling coil;

alternatively, an end of the guide element away from the thermal cycle liquid injection port extends upward and downward to form an upper outlet and a lower outlet, and both the upper and lower outlets are located at the inner side of the cooling coil.

7. The liquid storage device as claimed in claim 2, wherein the first and third side walls have working cycle drain ports, the thermal cycle liquid injection port is located at the top, and positioned at the center of the top, and an end of the guide element away from the thermal cycle liquid injection port extends toward the bottom to form a lower outlet;

wherein the cooling coil is fixed at the central position of the bottom, and the end of the guide element away from the thermal cycle liquid injection port is located at the inner side of the cooling coil.

8. The liquid storage device as claimed in any one of claims 2 to 7, wherein the cooling coil comprises a coil body, a base, and multiple supports vertically arranged on the base, the supports are arranged separating from each other along the circumference of the base, and the supports are provided with multiple mounting holes spaced along the height of the supports, the coil body is spiral-shaped and is secured in the multiple mounting holes.

9. The liquid storage device as claimed in claim 8, wherein each of the supports is provided with multiple sets of the mounting holes.

10. The liquid storage device as claimed in any one of claims 3 to 7, wherein the tank body comprises three working cycle drain ports, namely a first drain port, a second drain port, and a third drain port, the first drain port and the second drain port are spaced apart and located on the first side wall, while the third drain port is located on the third side wall.

11. The liquid storage device as claimed in claim 10, wherein the tank body further comprises a working cycle injection port and a thermal cycle drain port, the working cycle injection port is used to allow the solution flowing out from multiple work chambers to enter the tank body, and the thermal cycle drain port is used to allow the solution inside the tank body to flow out for heating;

wherein the working cycle injection port is located at the top of the tank body, and the thermal cycle drain port is located at the bottom of the tank body.

12. An electroplating apparatus, comprising a liquid storage device, wherein the liquid storage device adopts any one of the liquid storage devices as claimed in claims 1 to 11.

13. The electroplating apparatus as claimed in claim 12, further comprising multiple work chambers for depositing metal layers on the surface of substrates and multiple working pumps, the multiple work chambers being connected to the corresponding multiple working pumps, and the multiple working pumps being connected to the multiple working cycle drain ports, allowing the solution inside the tank body to be introduced into the corresponding work chambers.

14. The electroplating apparatus as claimed in claim 13, wherein when the tank body comprises three working cycle drain ports, namely a first drain port, a second drain port, and a third drain port, and the tank body further comprises the working cycle injection port and the thermal cycle drain port,

the multiple work chambers comprise a first work chamber, a second work chamber and a third work chamber, the multiple working pumps comprise a first working pump, a second working pump and a third working pump;

the first working pump and the first work chamber are sequentially connected between the first drain port and the working cycle injection port, forming the first working cycle loop;

the second working pump and the second work chamber are sequentially connected between the second drain port and the working cycle injection port, forming the second working cycle loop;

the third working pump and the third work chamber are sequentially connected between the third drain port and the working cycle injection port, forming the third working cycle loop.

15. The electroplating apparatus as claimed in claim 14, further comprising a thermal cycle pump and a heating device, the thermal cycle pump and the heating device are sequentially connected between the thermal cycle liquid injection port and the thermal cycle drain port to form a thermal cycle loop.