

WAFER CLEANING APPARATUS

FIELD OF THE INVENTION

The present application relates to the field of wafer cleaning, and in particular to a wafer cleaning apparatus.

BACKGROUND

Existing wafer cleaning equipment includes single-wafer sulfuric peroxide mixture (SPM) cleaning equipment and wet-batch SPM cleaning equipment. In single-wafer SPM cleaning equipment, the mixed, diluted sulfuric acid and hydrogen peroxide solution is recycled and reused, failing to meet the requirements of most processes. As a result, the sulfuric acid consumption of single-wafer SPM cleaning equipment will be much greater than the sulfuric acid consumption of wet-batch SPM cleaning equipment. Single-wafer SPM cleaning equipment consumes a large amount of SPM solution, while wet-batch SPM cleaning equipment consumes a small amount of SPM solution. In terms of particle removal effect, wet-batch SPM cleaning equipment is worse than single-wafer SPM cleaning equipment, and there are more small particles added. Generally speaking, wet-batch SPM cleaning equipment is suitable for removing particles larger than 60 nm, and single-wafer SPM cleaning equipment is suitable for removing particles smaller than 40 nm.

The cleaning equipment that combines wet-batch cleaning and single-wafer cleaning can save more SPM solution than single-wafer SPM cleaning equipment while ensuring the removal ability of particles smaller than 40 nm. However, as process requirements become more stringent, particles smaller than 26 nm need to be removed, current wet-batch SPM cleaning equipment or cleaning equipment for combined wet-batch and single-wafer SPM cleaning has reached the limit of further SPM solution savings.

SUMMARY

Embodiments of the present application provide a wafer cleaning apparatus, which can further save sulfuric acid, comprising:

a first cleaning tank, for storing SPM solution, and for performing a first cleaning on a wafer;

a second cleaning tank, for storing SPM solution, and for performing a second cleaning on the wafer;

a storage tank, for storing the SPM solution discharged from the second cleaning tank after the second cleaning tank performs the second cleaning on the wafer;

a first heater, for heating the SPM solution in the storage tank to a preset temperature range;

a controller, for controlling the storage tank to transfer the SPM solution heated to the preset temperature range by the first heater into the first cleaning tank when the first cleaning tank performs the SPM solution replacement.

In some embodiments, the wafer cleaning apparatus further comprises a concentration detector for detecting the concentration of the SPM solution in the storage tank and sending the concentration to the controller when the first cleaning tank performs the SPM solution replacement; the controller is used to compare the concentration of the SPM solution in the storage tank with a preset concentration, and control the storage tank to transfer the SPM solution heated to the preset temperature range by the first heater into the first cleaning tank when the concentration of the SPM solution in the storage tank is not less than the preset concentration.

In some embodiments, the controller controls the storage tank to discharge the SPM solution in the storage tank when the controller detects that the concentration of the SPM solution in the storage tank is less than the preset concentration.

In some embodiments, the wafer cleaning apparatus further comprises a first communication pipeline, the first cleaning tank includes a first inner tank and a first outer tank, the first inner tank is used for storing the SPM solution, the first outer tank is used for storing the SPM solution overflowing from the first inner tank; and the first communication pipeline connects the first inner tank and the first outer tank.

In some embodiments, a first buffer tank and a second heater are disposed on the

first communication pipeline, the first buffer tank connects the first outer tank, the first buffer tank also connects the first inner tank, and the second heater is disposed on the portion of the first communication pipeline between the first buffer tank and the first inner tank.

In some embodiments, a first filter is further disposed on the first communication pipeline, and the first filter is disposed between the first buffer tank and the second heater.

In some embodiments, the wafer cleaning apparatus further comprises a second communication pipeline, the second cleaning tank includes a second inner tank and a second outer tank, the second inner tank is used for storing the SPM solution, the second outer tank is used for storing the SPM solution overflowing from the second inner tank; and the second communication pipeline connects the second inner tank and the second outer tank.

In some embodiments, a second buffer tank and a third heater are disposed on the second communication pipeline, the second buffer tank connects the second outer tank, the second buffer tank also connects the second inner tank, and the third heater is disposed on the portion of the second communication pipeline between the second buffer tank and the second inner tank.

In some embodiments, a second filter is further disposed on the second communication pipeline, and the second filter is disposed between the second buffer tank and the third heater.

In some embodiments, at least one filter is further included, and the filter is disposed between the first heater and the storage tank.

In summary, the wafer cleaning apparatus provided by the embodiments of the present application solves the problem that the wet-batch SPM cleaning equipment or cleaning equipment for combined wet-batch and single-wafer SPM cleaning has reached the limit of further SPM solution savings by using the storage tank to store the SPM solution discharged from the second cleaning tank, and controlling the storage tank by the controller to transfer the SPM solution heated to a preset temperature range

by the first heater into the first cleaning tank when the first cleaning tank performs the SPM solution replacement, realizes the reuse of the SPM solution, and further saves the SPM solution.

Details of one or more embodiments of the present application are set forth in the following drawings and description to make other features, objects, and advantages of the present application more concise and easier to understand.

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 is a structural block diagram of a wafer cleaning apparatus according to an embodiment of the present application;

FIG. 2 is a schematic structure diagram of a wafer cleaning apparatus according to an embodiment of the present application.

PREFERRED EMBODIMENTS OF THE INVENTION

In order to make the object, technical solutions, and advantages of the present application more clearly understood, the present application is described and illustrated in conjunction with the accompanying drawings and embodiments. It is to be understood that the specific embodiments described herein are merely for illustration of the present application and are not intended to limit the present application. Based on the embodiments provided in the present application, all other embodiments obtained by those of ordinary skill in the art without making creative efforts fall within the scope of protection of the present application.

Unless otherwise defined, technical terms or scientific terms referred to in this application should have their ordinary meanings as understood by those of ordinary skill in the art to which this application belongs. Reference herein to such words as "a," "an," "one," "the," and the like does not mean a quantitative limitation and may mean the singular or plural. Reference herein to the terms "comprise," "include," "have," and any variations of the terms are intended to cover a non-exclusive inclusion; for example,

a process, method, system, product, or apparatus comprising a series of steps or modules (units) is not limited to the listed steps or units, but may also include steps or units not listed, or may also include other steps or units inherent to the process, method, product, or apparatus. The terms "connected," "interconnected," "coupled," and the like used herein are not limited to physical or mechanical connections, but may include electrical connections, whether direct or indirect. As used herein, the term "a plurality of " means more than or equal to two. The term "and/or" describes the association relationship of the association objects, indicating that there may be three kinds of relationships. For example, the term "A and/or B" may indicate that A alone exists, A and B simultaneously exist, and B alone exists. The terms "first," "second," "third," and the like referred to in the present application are merely to distinguish similar objects, and do not represent a specific ordering of the objects.

The embodiments of the present application provide a wafer cleaning apparatus. FIG. 1 is a structural block diagram of a wafer cleaning apparatus according to an embodiment of the present application. As shown in FIG. 1, the wafer cleaning apparatus comprises a first cleaning tank 10, a second cleaning tank 20, a storage tank 30, a first heater 40, and a controller 50. The first cleaning tank 10 is used for storing the SPM solution and performing a first cleaning on a wafer. The second cleaning tank 20 is used for storing the SPM solution and performing a second cleaning on the wafer. The storage tank 30 is used for storing the SPM solution discharged from the second cleaning tank 20. The first heater 40 is used for heating the SPM solution in the storage tank 30 to a preset temperature range. When the SPM solution is replaced in the first cleaning tank 10, the controller 50 controls the storage tank 30 to transfer the SPM solution heated to the preset temperature range by the first heater 40 into the first cleaning tank 10.

It should be noted that the cleaning equipment is usually provided with two SPM tanks, wherein the first cleaning tank is used for performing the first cleaning on the wafer, the concentration of the SPM solution in the first cleaning tank is relatively low, the second cleaning tank is used for performing the second cleaning on the wafer, and the cleaning degree of the wafer during the second cleaning is higher than the cleaning degree of the wafer during the first cleaning. Therefore, the consumption of the SPM solution of the second cleaning is less than the consumption of the SPM solution of the

first cleaning, and the concentration of the SPM solution of the second cleaning is relatively high. In the prior art, when one of the cleaning tanks reaches the SPM solution replacement cycle or the number of wafers to be processed reaches a preset number, all the SPM solutions in the two cleaning tanks are discharged, and a new SPM solution is supplemented from the factory. In the wafer cleaning apparatus provided by the present application, the SPM solution having a higher concentration in the second cleaning tank 20 is discharged into the storage tank 30, and the SPM solution in the storage tank 30 can be supplied to the first cleaning tank 10 when the SPM solution is replaced in the first cleaning tank 10, thereby reducing the amount of the SPM solution replenished from the factory, realizing the secondary utilization of the SPM solution having the higher concentration, prolonging the service life, and saving the usage amount of the SPM solution.

Specifically, the SPM solution includes sulfuric acid and hydrogen peroxide, and the amount of saved SPM solution described in the embodiments of the present application can be understood as the amount of saved sulfuric acid in the SPM solution, as shown in Table 1 below, wherein the unit of sulfuric acid (H_2SO_4) in Table 1 is L, and the number in the table represents the number of wafers being cleaned.

Table 1 Sulfuric Acid Usage Scale

Condition		One SPM tank	Two SPM tanks	The two SPM tanks optimized by the embodiments of the present application
Number		250	500	500
Wet-batch cleaning equipment/Cleaning equipment for combined wet-batch and single-wafer cleaning	Total H_2SO_4 usage	42.84	85.68	52.98
	Total H_2SO_4 usage/wafer	0.17	0.17	0.11
	H_2SO_4 saving rate	73.6%	73.6%	83.7%

As can be seen from Table 1, the wafer cleaning apparatus provided in the present application can be used on the basis of existing wet-batch cleaning equipment or cleaning equipment for combined wet-batch and single-wafer cleaning, and the sulfuric acid in the SPM solution is further saved.

In some embodiments, at least one filter can also be disposed between the first heater 40 and the storage tank 30 to facilitate the filtration of particles carried by the SPM solution discharged from the second cleaning tank 20.

In some embodiments, the first cleaning tank 10 and the second cleaning tank 20 can be synchronously replaced with the SPM solution, that is, when the SPM solution is replaced, the solution is simultaneously discharged first, the SPM solution in the first cleaning tank 10 is directly discharged, the SPM solution in the second cleaning tank 20 is discharged into the storage tank 30, and when a new SPM solution is added, the solution in the storage tank 30 is added into the first cleaning tank 10, and the new SPM solution is added into the second cleaning tank 20. The simultaneous replacement of the SPM solution improves the efficiency of replacing the SPM solution in the first cleaning tank 10 and the second cleaning tank 20.

In some embodiments, the wafer cleaning apparatus further comprises a concentration detector. In the first cleaning tank 10, when the SPM solution is replaced, the concentration detector detects the concentration of the SPM solution in the storage tank 30 and sends the concentration to the controller 50. The controller 50 compares the concentration of the SPM solution in the storage tank 30 with a preset concentration, and controls the storage tank 30 to transfer the SPM solution heated to a preset temperature range by the first heater 40 into the first cleaning tank 10 when the concentration of the SPM solution in the storage tank 30 is not less than the preset concentration. The concentration of the SPM solution in the storage tank 30 is detected by the concentration detector, so as to prevent the concentration of the SPM solution in the storage tank 30 from becoming too low and affecting the cleaning effect in the first cleaning tank 10. The preset concentration can be determined according to process requirements.

It should be noted that the concentration detector can detect the concentration of the SPM solution by detecting the concentration of the sulfuric acid in the SPM

solution.

In some embodiments, when the controller 50 detects that the concentration of the SPM solution in the storage tank 30 is less than a preset concentration, the controller 50 controls the storage tank 30 to discharge the SPM solution.

According to FIG. 2, in some embodiments, the wafer cleaning apparatus further comprises a first communication pipeline. The first cleaning tank 10 includes a first inner tank 11 and a first outer tank 12. The first inner tank 11 is used for storing the SPM solution, and the first outer tank 12 is used for storing the SPM solution overflowing from the first inner tank 11. The first communication pipeline is used to connect the first inner tank 11 and the first outer tank 12. In the present embodiment, the first inner tank 11 and the first outer tank 12 are connected through the first communication pipeline, the circulation of the liquid in the first cleaning tank 10 can be realized, and the concentration of the solution at all positions in the first cleaning tank 10 can be ensured to be uniform, thereby achieving a better cleaning effect.

As still shown in FIG. 2, a first buffer tank 13 and a second heater 14 are disposed on the first communication pipeline. The first buffer tank 13 connects the first outer tank 12, the first buffer tank 13 also connects the first inner tank 11, and the second heater 14 is disposed on the portion of the first communication pipeline between the first buffer tank 13 and the first inner tank 11. In the present embodiment, the first buffer tank 13 is disposed on the first communication pipeline, so that the SPM solution in the first outer tank 12 can be buffered, and the second heater 14 is disposed on the first communication pipeline, so that the circulating SPM solution can be heated, thereby improving the cleaning effect of the SPM solution. At the same time, providing the first buffer tank 13 can also facilitate the heating of the circulating SPM solution by the second heater 14, and prevent the SPM solution from flowing through the first communication pipeline at an excessive rate, which can otherwise prevent the SPM solution from being heated to a preset temperature range, and thus reduce the cleaning effect of the SPM solution.

As shown in FIG. 2, one or more first filters 15 are also disposed on the first communication pipeline, and the first filters 15 are disposed between the first buffer tank 13 and the second heater 14. In this embodiment, the SPM solution in circulation

is filtered by first filters 15, which prevents the SPM solution from carrying particles in the circulation process and affecting the subsequent cleaning effect of the wafer. The first filters 15 can be disposed on the two pipelines, respectively, in order to improve the filtration efficiency of the circulating SPM solution.

According to FIG. 2, the wafer cleaning apparatus further comprises a second communication pipeline. The second cleaning tank 20 includes a second inner tank 21 and a second outer tank 22. The second inner tank 21 is used for storing the SPM solution, and the second outer tank 22 is used for storing the SPM solution overflowing from the second inner tank 21. The second communication pipeline connects the second inner tank 21 and the second outer tank 22. In this embodiment, the second inner tank 21 and the second outer tank 22 are connected through the second communication pipeline, so that the circulation of the liquid in the second cleaning tank 20 can be realized, and the concentration of the solution at all positions in the second cleaning tank 20 can be ensured to be uniform, thereby achieving a better cleaning effect.

According to FIG. 2, a second buffer tank 23 and a third heater 24 are disposed on the second communication pipeline. The second buffer tank 23 connects the second outer tank 22, the second buffer tank 23 also connects the second inner tank 21, and the third heater 24 is disposed on the portion of the second communication pipeline between the second buffer tank 23 and the second inner tank 21. In the present embodiment, the second buffer tank 23 is disposed on the second communication pipeline, so that the SPM solution in the second outer tank 22 can be buffered, the third heater 24 is disposed on the second communication pipeline, so that the circulating SPM solution can be heated, thereby improving the cleaning effect of the SPM solution. At the same time, providing the second buffer tank 23 can also facilitate the heating of the circulating SPM solution by the third heater 24, thereby preventing the SPM solution from flowing through the second communication pipeline at an excessive rate, which can otherwise prevent the SPM solution from being heated to a preset temperature range, and thus reduce the cleaning effect of the SPM solution.

According to FIG. 2, one or more second filters 25 are also disposed on the second communication pipeline, and the second filters 25 are disposed between the second buffer tank 23 and the third heater 24. In the present embodiment, by filtering the SPM

solution in circulation by the second filters 25, it is possible to prevent the SPM solution from carrying particles in the circulation process, which can otherwise affect the subsequent cleaning effect of the wafer.

In some embodiments, the preset temperature range is between 80 °C to 100 °C. In the present embodiment, by setting the preset temperature range between 80 °C and 100 °C, the cleaning effect of the SPM solution can be improved.

As still shown in FIG. 2, a three-way valve 60 can also be disposed on the second communication pipeline for controlling the flow direction of the SPM solution, for example, when the SPM solution is replaced, the second cleaning tank 20 connects the storage tank 30, and when the SPM solution is not replaced, the second cleaning tank 20 connects the second communication pipeline, so that the solution is circulated in the second cleaning tank 20.

It will be understood by those skilled in the art that various technical features of the above-described embodiments can be combined arbitrarily. In order to simplify the description, not all possible combinations of the various technical features in the embodiments described above have been described. However, provided that the combinations of these technical features entail no technical inconsistency, any such combinations shall be regarded as falling within the scope of the present specification.

The above-described embodiments only express several embodiments of the present application, and the description of the embodiments is relatively specific and detailed, but should not be construed as limiting the patent scope of the invention accordingly. It should be pointed out that for those of ordinary skill in the art, some modifications and improvements can be made without departing from the concept of the present application, and these modifications and improvements fall within the scope of protection of the present application. Therefore, the scope of protection of this patent application shall be defined by the appended claims.

What is claimed is:

1. A wafer cleaning apparatus, comprising:

a first cleaning tank, for storing SPM solution, and for performing a first cleaning on a wafer;

a second cleaning tank, for storing SPM solution, and for performing a second cleaning on the wafer;

a storage tank, for storing the SPM solution discharged from the second cleaning tank after the second cleaning tank performs the second cleaning on the wafer;

a first heater, for heating the SPM solution in the storage tank to a preset temperature range;

a controller, for controlling the storage tank to transfer the SPM solution heated to the preset temperature range by the first heater into the first cleaning tank when the first cleaning tank performs the SPM solution replacement.

2. The wafer cleaning apparatus according to claim 1, further comprising a concentration detector, wherein the concentration detector is used for detecting the concentration of the SPM solution in the storage tank and sending the concentration to the controller when the first cleaning tank performs the SPM solution replacement; the controller is used for comparing the concentration of the SPM solution in the storage tank with a preset concentration, and when the concentration of the SPM solution in the storage tank is not less than the preset concentration, the controller controls the storage tank to transfer the SPM solution heated to the preset temperature range by the first heater into the first cleaning tank.

3. The wafer cleaning apparatus according to claim 2, wherein the controller controls the storage tank to discharge the SPM solution in the storage tank when the controller detects that the concentration of the SPM solution in the storage tank is less than the preset concentration.

4. The wafer cleaning apparatus according to claim 1, further comprising a first

communication pipeline, the first cleaning tank including a first inner tank and a first outer tank, the first inner tank being used for storing the SPM solution, the first outer tank being used for storing the SPM solution overflowing from the first inner tank; and the first communication pipeline connecting the first inner tank and the first outer tank.

5. The wafer cleaning apparatus according to claim 4, further comprising a first buffer tank and a second heater which are disposed on the first communication pipeline, the first buffer tank connecting the first outer tank, the first buffer tank also connecting the first inner tank, and the second heater being disposed on the portion of the first communication pipeline between the first buffer tank and the first inner tank.

6. The wafer cleaning apparatus according to claim 5, further comprising a first filter which is further disposed on the first communication pipeline, and the first filter being disposed between the first buffer tank and the second heater.

7. The wafer cleaning apparatus according to claim 1, further comprising a second communication pipeline, wherein the second cleaning tank includes a second inner tank and a second outer tank, the second inner tank is used for storing the SPM solution, the second outer tank is used for storing the SPM solution overflowing from the second inner tank; and the second communication pipeline connects the second inner tank and the second outer tank.

8. The wafer cleaning apparatus according to claim 7, further comprising a second buffer tank and a third heater which are disposed on the second communication pipeline, the second buffer tank connecting the second outer tank, the second buffer tank also connecting the second inner tank, and the third heater being disposed on the portion of the second communication pipeline between the second buffer tank and the second inner tank.

9. The wafer cleaning apparatus according to claim 8, further comprising a second filter which is further disposed on the second communication pipeline, and the second filter being disposed between the second buffer tank and the third heater.

10. The wafer cleaning apparatus according to claim 1, further comprising at least one filter disposed between the first heater and the storage tank.