

THERMOSTATIC GAS/LIQUID MIXTURE GENERATING SYSTEM FOR USE IN WAFER DRYING PROCESS

BACKGROUND OF THE INVENTION

5 1. Technical Field

The present invention relates to a wafer drying system, and more particularly, to a thermostatic gas/liquid mixture generating system capable of safely generating and heating a gas for drying wafers.

2. Description of Related Art

10 One of the various drying techniques for use in a wafer drying process comprises mixing an inert gas, such as nitrogen (N_2), with a nebulized organic solvent, such as isopropyl alcohol (IPA), heating and thereby evaporating the resultant mixture into a vapor, causing the vapor to contact a wafer so as to replace pure water or moisture left on the wafer from a wafer cleaning process, and then
15 using heated nitrogen to evaporate the IPA, so that the wafer is dried.

The aforesaid principle is employed in the widely used Kimmon IPA vapor dryer. Therein, an organic solvent, such as IPA, is heated to over 200°C to evaporate. The resultant IPA vapor replaces pure water or moisture on a surface of a wafer. Then, nitrogen (N_2) is heated, so that the heated nitrogen evaporates the liquid IPA
20 and thereby dries the wafer. Since IPA is an inflammable liquid, the method described above may cause fire and create safety concerns.

Taiwan Patent Publication No. 200714843, filed by Tokyo Electron Limited, discloses a vapor drying method and an apparatus thereof. In the disclosed apparatus, liquid IPA and nitrogen are mixed in a mixing chamber, then delivered to a vapor
25 generating device and heated therein to generate a vapor for drying wafers. The vapor generating device uses a light energy source as a heating source, which comprises a container body, a halogen lamp, heat insulating material and a spiral

tube. Although the vapor generating device can heat a mixture of IPA and N₂ mildly with the light energy source, the complicated structure of the vapor generating device results in a relatively high equipment cost.

In order to solve the safety problem of the conventional drying gas generating equipment and offer a low-cost apparatus having a simple structure, the present invention provides a thermostatic gas/liquid mixture generating system for use in a wafer drying process, as an improvement over the technical structure of the prior art to overcome the aforementioned safety problem.

10 SUMMARY OF THE INVENTION

In view of the foregoing problems, the present invention provides a novel, thermostatic gas/liquid mixture generating system for use in a wafer drying process, wherein the system is configured to generate and heat a gas for drying wafers. The present invention also provides a wafer drying system which uses the gas generated by the aforesaid thermostatic gas/liquid mixture generating system to dry wafers.

One objective of the present invention is to provide a thermostatic gas/liquid mixture generating system for use in a wafer drying process, wherein a mixture of nitrogen (N₂) and isopropyl alcohol (IPA) is heated via a water bath to achieve an ideal temperature, thereby preventing a process temperature of the mixture from being affected by a nitrogen temperature at a supply end.

Another objective of the present invention is to provide a thermostatic gas/liquid mixture generating system for use in a wafer drying process, wherein a mixed gas for drying wafers can be generated and heated in a safer manner.

Still another objective of the present invention is to provide a wafer drying system capable of drying wafers in a safer and more stable environment.

To achieve the foregoing objectives, a thermostatic gas/liquid mixture generating system for use in a wafer drying process according to the present

invention comprises an inner tank, a first liquid supplying device, a gas supplying device, an exhausting device, an outer tank, a second liquid supplying device, a temperature controlling device and a draining device. The first liquid supplying device is used to supply a first liquid into the inner tank, wherein the first liquid is liquid isopropyl alcohol (IPA). The gas supplying device is used to supply a gas into the inner tank, wherein the gas is nitrogen (N_2), so that the gas is mixed with the first liquid to generate a mixed gas (IPA+ N_2). The gas supplying device further comprises a gas inlet and a bottom gas outlet, wherein the bottom gas outlet is in communication with the gas inlet for supplying the gas into the inner tank from a bottom of the inner tank, and the bottom gas outlet is provided with at least one gas outlet hole and distributed generally over the entire bottom of the inner tank. The exhausting device is used to exhaust the mixed gas from the thermostatic gas/liquid mixture generating system for use in a wafer drying process. The outer tank is spaced apart from the inner tank. The second liquid supplying device is used to supply a second liquid into the outer tank, wherein the second liquid has a temperature higher than a room temperature and can be a treated industrial water. The temperature controlling device is used to control a temperature of the second liquid in the outer tank to an appropriate temperature range, wherein the appropriate temperature range is about 45°C to 80°C. The outer tank further comprises at least one partition for defining a flow path of the second liquid. The draining device is used to drain the second liquid out of the outer tank. The thermostatic gas/liquid mixture generating system for use in a wafer drying process according to the present invention can further comprise a liquid level detecting device disposed in the inner tank for measuring a liquid level of the first liquid, wherein the liquid level detecting device can be of a float type. The thermostatic gas/liquid mixture generating system can also comprise a thermometer for measuring the temperature of the second liquid.

To achieve the foregoing objectives, a wafer drying system according to the

present invention comprises a liquid supplier, a gas supplier, a thermostatic gas/liquid mixture generating device and a wafer drying apparatus. The liquid supplier is used to supply a first liquid, wherein the first liquid is liquid isopropyl alcohol (IPA). The gas supplier is used to supply a gas, wherein the gas is nitrogen (N₂). The thermostatic gas/liquid mixture generating device is in communication with the liquid supplier and the gas supplier for introducing therefrom the first liquid and the gas, and mixing the first liquid with the gas to generate a mixed gas. The thermostatic gas/liquid mixture generating device comprises an inner tank, a first liquid supplying device, a gas supplying device, an exhausting device, an outer tank, a second liquid supplying device, a temperature controlling device and a draining device. The wafer drying apparatus is in communication with the thermostatic gas/liquid mixture generating device for introducing therefrom the mixed gas and thereby drying a wafer. The wafer drying apparatus further comprises a wafer drying chamber including at least one nozzle. The wafer drying system according to the present invention further comprises a gas transmitting device for transmitting the mixed gas from the thermostatic gas/liquid mixture generating device to the wafer drying chamber. The gas transmitting device is also in communication with the nozzle, so that the nozzle can supply the mixed gas to the wafer drying chamber to dry a wafer.

The present invention provides the following advantages over the conventional wafer drying devices:

1. The thermostatic gas/liquid mixture generating system for use in a wafer drying process according to the present invention has a double-tank design, so that the second liquid, which is controlled at 45°C to 80°C, can be supplied into the outer tank to heat the mixed gas of isopropyl alcohol (IPA) and nitrogen (N₂) to an ideal temperature via a water bath. Compared with the conventional approach of directly heating isopropyl alcohol (IPA) or nitrogen (N₂), the present invention ensures a

safer heating process.

2. The wafer drying system of the present invention is integrated with the thermostatic gas/liquid mixture generating system, so that anti-explosion devices can be dispensed with to lower equipment costs, and the wafer drying process can be
5 conducted in a safer and more stable environment.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention as well as a preferred mode of use, further objectives and advantages thereof will best be understood by reference to the following detailed
10 description of illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a perspective view of a thermostatic gas/liquid mixture generating system for use in a wafer drying process according to an embodiment of the present invention;

15 Fig. 2 is another perspective view of the thermostatic gas/liquid mixture generating system for use in a wafer drying process according to the embodiment of the present invention, showing partitions in an outer tank of the system for defining a flow path of a second liquid; and

Fig. 3 is a schematic drawing showing major elements and a structure of a wafer
20 drying system according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figs. 1 and 2, a thermostatic gas/liquid mixture generating system 100 for use in a wafer drying process according to an embodiment of the present
25 invention comprises an inner tank 110, a first liquid supplying device 120, a gas supplying device 130, an exhausting device 140, an outer tank 150, a second liquid supplying device 160, a temperature controlling device 170 and a draining device

180.

The first liquid supplying device 120 is used to supply a first liquid L1 into the inner tank 110, wherein the first liquid L1 is liquid isopropyl alcohol (IPA). The gas supplying device 130 is used to supply a gas G1 into the inner tank 110, wherein the gas G1 is nitrogen (N_2). When the liquid isopropyl alcohol (IPA), i.e., the first liquid L1, and the nitrogen (N_2), i.e., the gas G1, are both supplied into the inner tank 110 and mixed with each other, a mixed gas G2 of IPA and N_2 is generated for use in a wafer drying process to dry wafers. The gas supplying device 130 further comprises a gas inlet 132 and a bottom gas outlet 134, which is in communication with the gas inlet 132 for supplying the gas G1 into the inner tank 110 from a bottom of the inner tank 110. The bottom gas outlet 134 is provided with at least one gas outlet hole 136 and distributed generally over the entire bottom of the inner tank 110. The exhausting device 140 is used to exhaust the mixed gas G2 out of the thermostatic gas/liquid mixture generating system 100 for use in a wafer drying process.

The outer tank 150 is spaced apart from the inner tank 110. The second liquid supplying device 160 supplies a second liquid L2 into the outer tank 150, wherein the second liquid L2 has a temperature higher than a room temperature and can be a treated industrial water. The second liquid L2 to be supplied into the outer tank 150 flows through the temperature controlling device 170, so that a temperature of the second liquid L2 is controlled to an appropriate temperature range, wherein the appropriate temperature range is about 45°C to 80°C. The outer tank 150 further comprises at least one partition 152 for defining a flow path of the second liquid L2. The draining device 180 drains the second liquid L2 out of the outer tank 150.

The thermostatic gas/liquid mixture generating system 100 for use in a wafer drying process according to the present invention can further comprise: a liquid level detecting device 112 disposed in the inner tank 110 for measuring a liquid level of the first liquid L1, wherein the liquid level detecting device 112 can be of a float type;

and a thermometer 154 for measuring the temperature of the second liquid L2.

Referring to Figs. 1, 2 and 3, a wafer drying system 300 according to a second embodiment of the present invention comprises a liquid supplier 310, a gas supplier 320, a thermostatic gas/liquid mixture generating system 100, a gas transmitting device 330 and a wafer drying apparatus 200. The liquid supplier 310 is used to supply a first liquid L1, wherein the first liquid L1 is liquid isopropyl alcohol (IPA). The gas supplier 320 is used to supply a gas G1, wherein the gas G1 is nitrogen (N_2). The thermostatic gas/liquid mixture generating system 100 is in communication with the liquid supplier 310 and the gas supplier 320 for introducing therefrom the first liquid L1 and the gas G1, mixing the first liquid L1 with the gas G1 to generate a mixed gas G2, and providing a temperature higher than a room temperature for heating the mixed gas G2. The thermostatic gas/liquid mixture generating system 100 comprises an inner tank 110, a first liquid supplying device 120, a gas supplying device 130, an exhausting device 140, an outer tank 150, a second liquid supplying device 160, a temperature controlling device 170 and a draining device 180. Therein, the first liquid supplying device 120 is in communication with the liquid supplier 310 for introducing the first liquid L1 into the inner tank 110, and the gas supplying device 130 is in communication with the gas supplier 320 for introducing the gas G1 into the inner tank 110. After being introduced into the inner tank 110, the first liquid L1 and the gas G1 are mixed therein to generate the mixed gas G2, which, when heated, becomes a wafer drying gas having a better drying effect. The heated mixed gas is then introduced into the wafer drying apparatus 200 to dry a wafer 1.

In order to heat the mixed gas G2 safely, the thermostatic gas/liquid mixture generating system 100 according to the present invention heats the mixed gas G2 via a water bath, as explained below. The second liquid supplying device 160 supplies a second liquid L2 into the outer tank 150 of the thermostatic gas/liquid mixture generating system 100, wherein the second liquid L2 has a temperature higher than a

room temperature and can be a treated industrial water. Before being supplied into the outer tank 150, the second liquid L2 flows through the temperature controlling device 170, so that a temperature of the second liquid L2 is controlled to an appropriate temperature range, wherein the appropriate temperature range is about 45°C to 80°C. The thermostatic gas/liquid mixture generating system 100 of the present invention further comprises a thermometer 154 for detecting whether or not the temperature of the second liquid L2 in the outer tank 150 is in the appropriate temperature range. When the second liquid L2 having a certain temperature is supplied into the outer tank 150, the mixed gas G2 in the inner tank 110 is heated to an appropriate temperature. The outer tank 150 further comprises at least one partition 152 for defining a flow path of the second liquid L2, so that the second liquid L2 flows uniformly through every part of the outer tank 150, and thereby uniformly heats every part of the inner tank 110, which is surrounded by the outer tank 150. The second liquid L2 in the outer tank 150 is eventually drained from the outer tank 150 by the draining device 180, and may be recycled for further use, such as for use in a factory.

After being heated in the thermostatic gas/liquid mixture generating system 100, the mixed gas G2 is discharged from the thermostatic gas/liquid mixture generating system 100 by the exhausting device 140, and transmitted by the gas transmitting device 330 to a wafer drying chamber 210 in the wafer drying apparatus 200. The gas transmitting device 330, the exhausting device 140 and a nozzle 212 of the wafer drying chamber 210 are in communication with one another, wherein the nozzle 212 is used to supply the mixed gas G2 transmitted by the gas transmitting device 330 to the wafer drying chamber 210 in the wafer drying apparatus 200. The wafer drying system 300 described above is integrated with the thermostatic gas/liquid mixture generating system 100 for use in a wafer drying process according to the present invention, so that a wafer drying gas for use in a wafer drying process can be

generated and heated via a water bath in a safer and more stable environment. Since the entire system can dispense with anti-explosion devices and has a simple structure, the cost of the system can be lowered.

5 The present invention has been clearly described with reference to preferred embodiments thereof and the accompanying drawings. It is understood, however, that the embodiments are illustrative only and not intended to limit the scope of the present invention. Therefore, all changes and modifications made to the elements described above that do not depart from the spirit and scope of the present invention should be encompassed by the present invention, which is defined by the appended
10 claims.

CLAIMS

1. A thermostatic gas/liquid mixture generating system for use in a wafer drying process, comprising:
 - an inner tank;
 - 5 a first liquid supplying device for supplying a first liquid into said inner tank;
 - a gas supplying device for supplying a gas into said inner tank, wherein said gas is mixed with said first liquid to generate a mixed gas;
 - an exhausting device for exhausting said mixed gas from said thermostatic
 - 10 gas/liquid mixture generating system;
 - an outer tank spaced apart from said inner tank;
 - a second liquid supplying device for supplying a second liquid into said outer tank;
 - a temperature controlling device for controlling a temperature of said
 - 15 second liquid to an appropriate temperature range; and
 - a draining device for draining said second liquid out of said outer tank.
2. The thermostatic gas/liquid mixture generating system of claim 1, wherein said gas supplying device further comprises:
 - a gas inlet; and
 - 20 a bottom gas outlet in communication with said gas inlet for supplying said gas into said inner tank from a bottom of said inner tank.
3. The thermostatic gas/liquid mixture generating system of claim 2, wherein said bottom gas outlet is provided with at least one gas outlet hole.
4. The thermostatic gas/liquid mixture generating system of claim 2, wherein said
- 25 bottom gas outlet is distributed generally over the entire bottom of said inner tank.
5. The thermostatic gas/liquid mixture generating system of any one of the

- preceding claims, wherein said gas supplying device supplies nitrogen (N₂).
6. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, wherein said first liquid is liquid isopropyl alcohol (IPA).
 7. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, further comprising a liquid level detecting device disposed in said inner tank.
 8. The thermostatic gas/liquid mixture generating system of Claim 7, wherein said liquid level detecting device is of a float type.
 9. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, wherein the temperature of said second liquid in said outer tank is higher than a room temperature.
 10. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, wherein said temperature controlling device controls the temperature of said second liquid to an appropriate temperature range of about 45°C to 80°C.
 11. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, wherein said second liquid is a treated industrial water.
 12. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, further comprising a thermometer for measuring the temperature of said second liquid.
 13. The thermostatic gas/liquid mixture generating system of any one of the preceding claims, wherein said outer tank further comprises at least one partition for defining a flow path of said second liquid.
 14. A wafer drying system, comprising:
 - a liquid supplier for supplying a first liquid;
 - a gas supplier for supplying a gas;
 - a thermostatic gas/liquid mixture generating system in communication

with said liquid supplier and said gas supplier for introducing therefrom said first liquid and said gas, and mixing said first liquid with said gas to generate a mixed gas, said thermostatic gas/liquid mixture generating system comprising:
an inner tank;

5 a first liquid supplying device for supplying said first liquid from said liquid supplier into said inner tank;

 a gas supplying device for supplying said gas from said gas supplier into said inner tank, wherein said gas is mixed with said first liquid to generate a mixed gas;

10 an exhausting device for exhausting said mixed gas from said thermostatic gas/liquid mixture generating system;

 an outer tank spaced apart from said inner tank;

 a second liquid supplying device for supplying a second liquid into said outer tank;

15 a temperature controlling device for controlling a temperature of said second liquid to an appropriate temperature range; and

 a draining device for draining said second liquid out of said outer tank; and

 a wafer drying apparatus in communication with said gas/liquid mixture generating device for introducing therefrom said mixed gas and thereby drying a wafer.

15. The wafer drying system of claim 14, wherein said first liquid is liquid isopropyl alcohol (IPA).

16. The wafer drying system of claims 14 or 15, wherein said gas supplier supplies
25 nitrogen (N₂).

17. The wafer drying system of any one of claims 14 to 16, wherein said wafer drying apparatus further comprises a wafer drying chamber.

18. The wafer drying system of claim 17, further comprising a gas transmitting device for transmitting said mixed gas from said thermostatic gas/liquid mixture generating system to said wafer drying chamber.
19. The wafer drying system of claims 17 or 18, wherein said wafer drying chamber
5 further comprises at least one nozzle in communication with said gas transmitting device for supplying said mixed gas and thereby drying the wafer.
20. The wafer drying system of any one of claims 14 to 19, wherein said thermostatic gas/liquid mixture generating system provides a temperature higher than a room temperature.