SYSTEMS AND METHODS FOR A SPRAY MEASUREMENT APPARATUS

FIELD

[0001] The present disclosure generally relates to a spray measurement apparatus, and in particular to systems and methods for a spray measurement apparatus capable of detecting liquid capture levels of one or more spray nozzles within a batch chemical process chamber for understanding spray distribution patterns.

BACKGROUND

[0002] Batch chemical process chambers for semiconductor wet chemical processing require a plurality of spray nozzles to spray a chemical onto a number of wafers stacked in an array inside the process chamber in a uniform manner. The malfunctioning of one or more spray nozzles or a misadjusted spray nozzle(s) can lead to non-uniformity in spray distribution, thereby preventing consistent or in-specification batch process completion. In addition, once an issue in the spray nozzle assembly is identified, it can be difficult and time-consuming to disassemble the batch process chamber to identify which nozzle(s) are malfunctioning and to take corrective action. As such, there lacks a system for easily and accurately monitoring and measuring spray distribution within a batch chemical process chamber.

[0003] It is with these observations in mind, among others, that various aspects of the present disclosure were conceived and developed.

SUMMARY OF THE INVENTION

[0003a] According to a first aspect of the present invention, there is provided a spray measurement system, comprising:

a rotor disposed within a batch chemical processing chamber, wherein the rotor is operable to rotate around a horizontal axis Z, wherein the rotor is operable to rotate in a clockwise or counterclockwise direction A and an opposite clockwise or counterclockwise direction B;

a spray measurement apparatus in operative association with the rotor, the spray measurement apparatus comprising:

a jig device , comprising a plurality of slots, wherein each of the plurality of slots is operable to receive a blocker plate; and

one or more channels corresponding with one or more of the plurality of slots, wherein each of the one or more channels is in operative association with a respective pressure transducer for measuring an amount of liquid collected in the one or more channels;

wherein the spray measurement apparatus is operable to be rotated between a vertical resting position and a predetermined testing angle by the rotor;

and;

a controller in operative association with the rotor, wherein the controller is operable to rotate the rotor around the horizontal axis Z, wherein the controller is operable to rotate the rotor in the clockwise or counterclockwise direction A and the opposite clockwise or counterclockwise direction B between the vertical resting position and a predetermined testing angle;

wherein the spray measurement apparatus is operable to be rotated to a predetermined testing angle and receive an amount of liquid sprayed by a spray nozzle array into the one or more of the channels, wherein a data collection interface is operable to record the amount of liquid collected in each of the one or more channels.

[0003b] According to a second aspect of the present invention, there is provided a method of measuring spray output using a spray measurement system, comprising:

rotating a rotor in operative association with a spray measurement apparatus having a plurality of channels, wherein the rotor and spray measurement apparatus are rotated in a clockwise or counterclockwise direction A along a horizontal axis Z, wherein the rotor and spray measurement apparatus are rotated from a vertical position to a predetermined testing angle;

spraying an amount of liquid from a fixed spray nozzle array at the spray measurement apparatus, wherein a volume of liquid from the fixed spray nozzle array is collected into one or more of the plurality of channels of the spray measurement apparatus;

rotating the rotor in operative association with the spray measurement apparatus in an opposite counterclockwise or clockwise direction B along the horizontal axis Z such that the spray measurement apparatus having collected an amount of the liquid is returned to a vertical position; and

measuring the volume of liquid in one or more of the plurality of channels.

CLAIMS

What is claimed is:

1. A spray measurement system ~~(100)~~, comprising:

a rotor ~~(10)~~ disposed within a batch chemical processing chamber, wherein the rotor ~~(10)~~ is operable to rotate around a horizontal axis Z, wherein the rotor ~~(10)~~ is operable to rotate in a clockwise or counterclockwise direction A and an opposite clockwise or counterclockwise direction B;

a spray measurement apparatus ~~(101)~~ in operative association with the rotor~~(10)~~, the spray measurement apparatus ~~(101)~~ comprising:

a jig device ~~(102)~~, comprising a plurality of slots ~~(113)~~, wherein each of the plurality of slots ~~(113)~~ is operable to receive a blocker plate ~~(116)~~; and

one or more channels ~~(122, 123)~~ corresponding with one or more of the plurality of slots ~~(113)~~, wherein each of the one or more channels ~~(122, 123)~~ is in operative association with a respective pressure transducer ~~(130)~~ for measuring an amount of liquid collected in the one or more channels ~~(122, 123)~~;

wherein the spray measurement apparatus ~~(101)~~ is operable to be rotated between a vertical resting position and a predetermined testing angle by the rotor ~~(10)~~;

and;

a controller ~~(131)~~ in operative association with the rotor ~~(10)~~, wherein the controller ~~(131)~~ is operable to rotate the rotor ~~(10)~~ around the horizontal axis Z, wherein the controller ~~(131)~~ is operable to rotate the rotor ~~(10)~~ in the clockwise or counterclockwise direction A and the opposite clockwise or counterclockwise direction B between the vertical resting position and a predetermined testing angle;

wherein the spray measurement apparatus ~~(101)~~ is operable to be rotated to a predetermined testing angle and receive an amount of liquid sprayed

by a spray nozzle array ~~(12)~~ into the one or more of the channels ~~(122, 123)~~, wherein a data collection interface is operable to record the amount of liquid collected in each of the one or more channels ~~(122, 123)~~.

2. The system ~~(100)~~ of claim 1, wherein the spray nozzle array ~~(12)~~ remains in a fixed position angled above the spray measurement apparatus ~~(101)~~, wherein the spray nozzle array ~~(12)~~ is operable to spray the amount of liquid at the spray measurement apparatus ~~(101)~~.

3. The system ~~(100)~~ of claim 1, wherein each of the plurality of blocker plates ~~(116)~~ prevent liquid from entering a corresponding slot ~~(113)~~ of the plurality of slots ~~(113)~~, and wherein the manual removal of blocker plates ~~(116)~~ allows liquid to enter a corresponding slot of the plurality of slots ~~(113)~~.

4. The system ~~(100)~~ of claim 1, wherein the spray measurement apparatus ~~(101)~~ is secured within the rotor ~~(10)~~ using first and second side bar portions formed along respective opposite sides of a casing.

5. The system ~~(100)~~ of claim 1, wherein the controller ~~(131)~~ is operable to record and analyze information collected by the data collection interface.

6. The system ~~(100)~~ of claim 1, wherein a malfunctioning spray nozzle ~~(12)~~ of the spray nozzle array ~~(12)~~ is identified by measuring an amount of liquid collected in each of the plurality of channels ~~(122, 123)~~.

~~7. A spray measurement apparatus (101), comprising:~~

~~a casing (103) defining a top portion (107), a bottom portion (110), and opposing first and second side portions (108, 109), wherein the top portion (107) forms a top opening (127) in communication with an upper chamber (128) formed by a tank (121) disposed within the casing (103), wherein the tank (121) defines a plurality of channels (122, 123);~~

a jig device (**102**) disposed within the upper chamber (**128**), the jig device (**102**) comprising:

a slot assembly (**104**) comprising:

a plurality of slot plates (**117**) interposed between a plurality of slot blocks (**119**) for defining respective slots (**113**); and

a plurality of blocker plates (**116**) disposed within the slot assembly (**104**), wherein each of the plurality of blocker plates (**116**) is configured to be disposed within a respective slot (**113**) of the slot assembly (**104**), and wherein a respective slot (**113**) is associated with one of the plurality of channels (**122**, **123**) such that a liquid sprayed by one or more spray nozzles (**12**) at that respective slot (**113**) is collected at one of the plurality of channels (**122**, **123**);

a plurality of pressure transducers (**130**) in operative communication with the plurality of channels (**122**, **123**) for measuring the spray output of the one or more spray nozzles (**12**) at a respective slot (**113**) in which at least one blocker plate (**116**) has been removed, wherein each respective channel (**122**, **123**) is associated with a respective one of the plurality of pressure transducers (**130**); and

a data collection interface in operative communication with the plurality of pressure transducers for measuring the amount of liquid collected in the plurality of channels (**122**, **123**).

8. The apparatus (**101**) of claim 7, wherein a pressure value determined by one of the plurality of pressure transducers (**130**) is used to calculate a volume of liquid in one of the plurality of channels (**122**, **123**).

9. The apparatus (**101**) of claim 7, wherein the data collection interface is in operative communication with a controller (**131**), and wherein the controller

~~(131) is operable to record and analyze information collected by the data collection interface.~~

~~10. The apparatus (101) of claim 9, wherein the controller (131) is placed inside the casing (103) of the spray measurement apparatus (101).~~

~~11. The apparatus (101) of claim 9, wherein the controller (131) is external to the spray measurement apparatus (101).~~

~~12. The apparatus (101) of claim 7, wherein power is supplied to the spray measurement apparatus (101) by a battery (147).~~

~~13. The apparatus (101) of claim 7, wherein power is supplied to the spray measurement apparatus (101) by a wired connection.~~

~~14~~7. A method of measuring spray output using a spray measurement system ~~(100)~~, comprising:

rotating a rotor ~~(10)~~ in operative association with a spray measurement apparatus ~~(101)~~ having a plurality of channels ~~(122, 123)~~, wherein the rotor ~~(10)~~ and spray measurement apparatus ~~(101)~~ are rotated in a clockwise or counterclockwise direction A along a horizontal axis Z, wherein the rotor ~~(10)~~ and spray measurement apparatus ~~(101)~~ are rotated from a vertical position to a predetermined testing angle;

spraying an amount of liquid from a fixed spray nozzle array ~~(12)~~ at the spray measurement apparatus ~~(101)~~, wherein a volume of liquid from the fixed spray nozzle array ~~(12)~~ is collected into one or more of the plurality of channels ~~(122, 123)~~ of the spray measurement apparatus ~~(101)~~;

rotating the rotor ~~(10)~~ in operative association with the spray measurement apparatus ~~(101)~~ in an opposite counterclockwise or clockwise direction B along the horizontal axis Z such that the spray measurement apparatus ~~(101)~~ having collected an amount of the liquid is returned to a vertical position; and

measuring the volume of liquid in one or more of the plurality of channels ~~(122, 123)~~.

~~15~~8. The method of claim ~~14~~7, further comprising:

configuring one or more channels ~~(122, 123)~~ for testing of one or more of spray nozzles ~~(12)~~ by adding or removing one or more of a plurality of blocker plates ~~(116)~~, wherein each of the plurality of blocker plates ~~(116)~~ is configured to be disposed within a respective slot ~~(113)~~ of a slot assembly ~~(104)~~ of the spray measurement apparatus ~~(101)~~, wherein a respective slot ~~(113)~~ is associated with one of the plurality of channels ~~(122, 123)~~ such that the amount of liquid sprayed by one or more spray nozzles ~~(12)~~ at that respective slot ~~(113)~~ is collected at one of the plurality of channels ~~(122, 123)~~.

~~16~~9. The method of claim ~~14~~7, wherein the method of measuring spray output is repeated, wherein each repetition of the method of measuring spray output is at a different testing angle.

~~17~~10. The method of claim ~~16~~9, wherein a malfunctioning spray nozzle from the spray nozzle ~~(12)~~ array is identified by measuring the volume of liquid collected in each of the plurality of channels ~~(122, 123)~~ across one or more testing angles.

~~18~~11. The method of claim ~~14~~7, wherein the volume of liquid in a respective channel of the spray measurement apparatus ~~(101)~~ is measured by measuring the amount of pressure in the respective channel using a respective pressure transducer, wherein the amount of pressure in the channel corresponds to the volume of liquid collected in the channel.

~~19~~12. The method of claim ~~18~~11, wherein a data collection interface in operative communication with the pressure transducers ~~(130)~~ is operable to record and analyze data pertaining to the amount of pressure in each of the plurality of channels ~~(122, 123)~~.

~~20~~13. The method of claim ~~14~~7, wherein a controller ~~(131)~~ in operative communication with the rotor ~~(10)~~ is operable to rotate the rotor ~~(10)~~, thereby rotating the spray measurement apparatus ~~(101)~~.