ADJUSTABLE FLOW NOZZLE SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a PCT application that claims benefit to U.S. provisional application serial number 62/797,815 filed on January 28, 2019, which is herein incorporated by reference in its entirety.

FIELD

[0002] The present disclosure relates to an adjustable flow nozzle system; and in particular, to an adjustable flow nozzle system that adjusts the cross-sectional area of a collective opening formed by each adjustable flow nozzle by selective rotation of one component relative to another component with each component having a respective opening in overlapping arrangement with respect to one other to form the collective opening for controlling the flow rate of each individual adjustable flow nozzle.

BACKGROUND

[0003] Semiconductor processing involves selective removal of semiconducting materials, polymers or metals from the surface of base wafers including silicon. This is accomplished through spraying various chemicals – corrosive agents or solvents – on a batch of wafers. One of the many factors that influences the removal rate is the flow rate (or volume) of liquid moving through the spray nozzles. Currently, the adjustment of flow through each spray nozzle is done at the “macro” level by adjusting the total flow to all of the spray nozzles in the manifold at once. Individual spray nozzles can also be changed within the manifold, but this individual adjustment of each spray nozzle is both time consuming and may not precisely adjust the flow of liquid through each respective spray nozzle.

[0004] It is with these observations in mind, among others, that various aspects of the present disclosure were conceived and developed.

SUMMARY OF INVENTION

[0004a] According to a first aspect of the present invention, there is provided an adjustable flow nozzle system comprising:

an adjustable flow manifold comprising:

a manifold body defining an axial channel that extends between a distal end portion defining a distal opening and a proximal end portion defining a proximal opening;

a plurality of access openings formed along a first side of the manifold body; and

a plurality of apertures formed on an opposite second side of the manifold body;

wherein the plurality of access openings and the plurality of apertures communicate with the axial channel; and

a plurality of adjustable flow nozzles coupled to a respective one of the plurality of apertures, each of the plurality of adjustable flow nozzles comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber; ~~and~~

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer is rotated, wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the

stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; and

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of the collective opening is adjusted as the stem retainer is rotated.;

a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and

a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.

[0004b] According to a second aspect of the present invention, there is provided a method for adjusting the flow rate for an adjustable flow nozzle system comprising:

providing an adjustable flow manifold comprising:

a manifold body defining an axial channel that extends between a distal end portion defining a distal opening and a proximal end portion defining a proximal opening;

a plurality of access openings formed along a first side of the manifold body;

a plurality of apertures formed on an opposite second side of the manifold body, wherein the plurality of access openings and the plurality of apertures communicate with the axial channel; and

a plurality of adjustable flow nozzles coupled to a respective one of the plurality of apertures, each of the plurality of adjustable flow nozzles comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber;

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer is rotated, wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem

retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; and

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of collective opening is adjusted as the stem retainer is rotated;

inserting a first key having an elongated key body defining a proximal portion and a distal portion through one of the plurality of apertures, the first key further comprising at least one key element extending from the proximal portion of the elongated key body;

engaging the at least one key element of the first key with the nozzle retainer to maintain the nozzle retainer in a stationary position;

engaging a second key with the adjuster; and

rotating the second key such that the stem retainer is rotated relative to the stationary nozzle retainer for adjusting the cross-sectional area and flow rate through the collective opening.

[0004c] According to a third aspect of the present invention, there is provided an adjustable flow nozzle comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber;

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of

the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer is rotated, wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; ~~and~~

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of the collective opening is adjusted as the stem retainer is rotated~~.~~;

a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and

a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.

CLAIMS

What is claimed is:

1. An adjustable flow nozzle system comprising:

an adjustable flow manifold comprising:

a manifold body defining an axial channel that extends between a distal end portion defining a distal opening and a proximal end portion defining a proximal opening;

a plurality of access openings formed along a first side of the manifold body; and

a plurality of apertures formed on an opposite second side of the manifold body;

wherein the plurality of access openings and the plurality of apertures communicate with the axial channel; and

a plurality of adjustable flow nozzles coupled to a respective one of the plurality of apertures, each of the plurality of adjustable flow nozzles comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber; ~~and~~

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer

is rotated, wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; and

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of the collective opening is adjusted as the stem retainer is rotated.;

a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and

a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.

2. The adjustable flow nozzle system of claim 1, wherein adjusting the cross-sectional area of the collective opening adjusts the flow rate through each of the plurality of adjustable flow nozzles.

3. The adjustable flow nozzle system of claim 1, wherein the flow rate exiting each of the plurality of adjustable flow nozzles is within a range between a minimum flow rate and a maximum flow rate.

4. The adjustable flow nozzle system of claim 1, wherein the flow rate of the fluid exiting each adjustable flow nozzle is adjusted through the selective overlap of the first inlet opening of the stem retainer with the second inlet opening of

the nozzle retainer such that each adjustable flow nozzle is adjustable between a minimum flow rate when minimum overlap between the first inlet opening and the second inlet opening occurs and a maximum flow rate when maximum overlap between the first inlet opening and the second inlet opening occurs.

~~5. The adjustable flow nozzle system of claim 1, further comprising:~~

~~a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and~~

~~a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.~~

~~6~~5. The adjustable flow nozzle system of claim 1, wherein the fluid enters the axial channel of the adjustable flow nozzle system through the ~~proximal~~ distal opening, wherein the axial channel is in fluid flow communication with each of the plurality of adjustable flow nozzles such that the fluid enters the collective opening of one or more of the adjustable flow nozzles and wherein the fluid exits the one or more adjustable flow nozzles through the spray nozzle of the adjustable flow nozzle.

~~7~~6. The adjustable flow nozzle system of claim 1, wherein the manifold further comprises a plurality of nozzle cavities in communication with the axial channel and wherein each of the plurality of adjustable flow nozzles is disposed within a respective one of the plurality of nozzle cavities.

~~8~~7. A method for adjusting the flow rate for an adjustable flow nozzle system comprising:

providing an adjustable flow manifold comprising:

a manifold body defining an axial channel that extends between a distal end portion defining a distal opening and a proximal end portion defining a proximal opening;

a plurality of access openings formed along a first side of the manifold body;

a plurality of apertures formed on an opposite second side of the manifold body, wherein the plurality of access openings and the plurality of apertures communicate with the axial channel; and

a plurality of adjustable flow nozzles coupled to a respective one of the plurality of apertures, each of the plurality of adjustable flow nozzles comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber;

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer is rotated,

wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; and

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of collective opening is adjusted as the stem retainer is rotated;

inserting a first key having an elongated key body defining a proximal portion and a distal portion through one of the plurality of apertures, the first key further comprising at least one key element extending from the proximal portion of the elongated key body;

engaging the at least one key element of the first key with the nozzle retainer to maintain the nozzle retainer in a stationary position;

engaging a second key with the adjuster; and

rotating the second key such that the stem retainer is rotated relative to the stationary nozzle retainer for adjusting the cross-sectional area and flow rate through the collective opening.

~~9~~8. The method of claim ~~8~~7, wherein rotation of the stem retainer relative to the nozzle retainer adjusts the flow rate of each adjustable flow nozzle within a range between a minimum flow rate and a maximum flow rate.

~~10~~9. An adjustable flow nozzle comprising:

a spray nozzle configured for providing a fluid pathway for a fluid exiting the adjustable flow nozzle;

a stem retainer engaged to the spray nozzle, the stem retainer defining a first inlet opening and an axial opening in fluid flow communication with ~~a first~~ an internal chamber;

a nozzle retainer engaged to the spray nozzle, wherein the nozzle retainer defines a second inlet opening in communication with a ~~second~~ lower chamber and wherein the stem retainer is configured to be rotatably disposed within the ~~second~~ lower chamber of the nozzle retainer such that the first inlet opening of the stem retainer is in an overlapping arrangement with the second inlet opening of the nozzle retainer such that a collective opening is formed between the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer as the stem retainer is rotated, wherein the fluid enters the internal chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle; ~~and~~

an adjuster in operative engagement with the stem retainer for causing rotation of the stem retainer relative to the nozzle retainer such that the cross-sectional area of the collective opening is adjusted as the stem retainer is rotated~~.~~;

a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and

a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.

~~11. The adjustable flow nozzle of claim 10, further comprising:~~

~~a first key having an elongated key body defining a proximal portion and a distal portion and having at least one key element extending from the proximal portion of the elongated key body, the at least one key element being configured to engage the nozzle retainer to maintain the nozzle retainer in a stationary position; and~~

~~a second key configured to engage the adjuster for rotating the adjuster and the stem retainer together relative to the nozzle retainer.~~

~~12~~10. The adjustable flow nozzle of claim ~~10~~9, wherein the flow rate of the fluid through the adjustable flow nozzle is adjusted through the selective overlap of the first inlet opening of the stem retainer with the second inlet opening of the nozzle retainer such that the adjustable flow nozzle is adjustable between a minimum flow rate when minimum overlap between the first inlet opening and the second inlet opening occurs and a maximum flow rate when maximum overlap between the first inlet opening and the second inlet opening occurs.

~~13. The adjustable flow nozzle of claim 10, wherein the fluid enters the first chamber of the stem retainer through the collective opening defined by the first inlet opening of the stem retainer and the second inlet opening of the nozzle retainer and wherein the fluid enters the spray nozzle through the axial opening of the stem retainer, wherein the fluid leaves the adjustable flow nozzle through the spray nozzle.~~

~~14~~11. The adjustable flow nozzle of claim ~~10~~9, wherein the stem retainer is rotatable relative to the nozzle retainer and wherein an orientation of the second inlet opening of the nozzle retainer is fixed within a nozzle cavity of an adjustable flow manifold.

~~15~~12. The adjustable flow nozzle of claim ~~10~~9, wherein a stem portion defined by the stem retainer is engaged with ~~a first~~ an upper chamber defined by the

nozzle retainer and wherein a body portion of the stem retainer is engaged with the ~~second~~ lower chamber of the nozzle retainer, wherein the ~~first~~ upper chamber is ~~located superior~~ in communication with ~~to~~ the ~~second~~ lower chamber.