CLAIMS

What is claimed is:

1. A cleaning brush, comprising:

a core comprising:

a circumferential portion surrounding a rotation axis of the cleaning brush and defining an inlet opening for receiving a fluid; and

a closed end portion connected to an end of the circumferential portion that is opposite to the inlet opening along the rotation axis,

wherein at least one elongated conduit is defined within the core and fluidly communicated with the inlet opening, and the circumferential portion includes a plurality of outlet channels passing therethrough to fluidly communicate with the elongated conduit, the outlet channels being tilted outwardly toward the closed end portion; and

a brush member connected to an outer surface of the circumferential portion and covering all of the plurality of outlet channels.

2. The cleaning brush of claim 1, wherein the outlet channels are tilted toward the closed end portion by a tilt angle greater than or equal to 20 degrees but less than 90 degrees.

3. The cleaning brush of claim 2, wherein the plurality of outlet channels include a first outlet channel and a second outlet channel located closer to the closed end portion than the first outlet channel, wherein the tilt angle of the second outlet channel is greater than the tilt angle of the first outlet channel.

4. The cleaning brush of claim 1, wherein each of the outlet channels includes:

an upstream section connected to the inner surface of the circumferential portion; and

at least one downstream section connected the upstream section to the outer surface of the circumferential portion, wherein the upstream section is tilted relative to the inner surface of the circumferential portion and the downstream section is perpendicular to the outer surface of the circumferential portion.

5. The cleaning brush of claim 4, wherein each of the outlet channels includes two downstream sections diverging from the upstream section and extending to the outer surface of the circumferential portion, and a width of the two downstream sections is less than a width of the upstream section.

6. The cleaning brush of claim 4, wherein a width (D) of the elongated conduit, a width (W11) of the upstream section of one of the outlet channels, and a width (W13) of the downstream

section satisfy the following equations (1) and (2):

$$D^3 = \sum_{k=0}^{n} k(W11)^3 \ldots (1)$$

$$(W11)^3 = \sum_{i=0}^{n} i(W13)^3 \ldots (2),$$

where k is the total number of the upstream sections, and i is the total number of the downstream sections.

7. The cleaning brush of claim 1, wherein each of the outlet channels includes:

an upstream section connected to the inner surface of the circumferential portion; and

at least one downstream section connected the upstream section to the outer surface of the circumferential portion, wherein a cross-sectional shape of the upstream section is different from a cross-sectional shape of the downstream section.

8. The cleaning brush of claim 1, wherein the plurality of outlet channels comprise a first outlet channel and a second outlet channel located farther away from the inlet opening than the first outlet channel, and a cross-sectional shape or a dimension of the first outlet channel is different from a cross-sectional shape or a dimension of the second outlet channel.

9. The cleaning brush of claim 1, wherein the circumferential portion includes a round corner or a chamfer at an intersection of at least one of the outlet channels and the elongated conduit.

10. A CMP (chemical mechanical planarization) apparatus, comprising:

a CMP module configured to perform a CMP process over a semiconductor wafer; and

a post-CMP cleaning module positioned at a downstream of the CMP module and comprising the cleaning brush of claim 1.