CLAIMS

1. A gas injector comprising:

an inlet portion including an inlet hole on an inlet face of the inlet portion, the inlet portion to receive a processing gas introduced via the inlet hole during semiconductor processing, the inlet portion further including a conformal channel disposed between the inlet hole and a sidewall of the inlet portion;

an outlet portion including an outlet hole from which the processing gas is provided from the gas injector during the semiconductor processing, the outlet hole connected to the inlet hole; and

a collar disposed between the inlet portion and the outlet portion, the collar having a larger diameter than the inlet portion and the outlet portion, the conformal channel extending into the collar.

2. The gas injector of claim 1, wherein:

the conformal channel has a plurality of channel sections each of which extends through the inlet portion and terminates at inlet channel ends before reaching the inlet face.

3. The gas injector of claim 2, wherein:

each channel section also terminates at collar channel ends before reaching the outlet portion.

4. The gas injector of claim 3, wherein:

alternating adjacent pairs of channel sections are connected via the inlet channel ends such that each inlet channel end is separated from an adjacent inlet channel end, and

at least some of adjacent pairs of channel sections not connected via the inlet channel ends are connected via the collar channel ends.

5. The gas injector of claim 4, wherein:

the collar further comprises a sidewall having ports connected with at least one of the adjacent pairs of channel sections not connected via the inlet channel ends.

6. The gas injector of claim 4, wherein:

the conformal channel is a single channel that extends around substantially an entirety of the inlet hole.

7. The gas injector of claim 4, wherein:

at least one of the inlet channel ends or the collar channel ends of each channel section have an arcuate shape.

8. The gas injector of claim 7, wherein:

the inlet hole comprises a single inlet central bore and a plurality of secondary inlet holes surrounding the inlet central bore, the secondary inlet holes are equidistant from a center of the inlet central bore, each secondary inlet hole is equiangular from each adjacent secondary inlet hole,

the outlet hole comprises a single outlet central bore connected with the inlet central bore and a plurality of secondary outlet holes connected with the secondary inlet holes, the secondary outlet holes are disposed on a sidewall of the outlet portion, and

an arc of one of each inlet channel end or each collar channel end is centered angularly around a different secondary inlet hole.

9. The gas injector of claim 8, wherein:

an arc of at least another of each inlet channel end or each collar channel end is centered angularly between adjacent secondary inlet holes.

10. The gas injector of claim 8, wherein:

each channel section has a diameter smaller than a diameter of each secondary inlet hole.

11. The gas injector of claim 1, further comprising:

a connector integrally formed with the sidewall of the inlet portion, the connector sized to be connected to a gas manifold configured to supply the gas to the gas injector, the gas injector formed from a ceramic material.

12. The gas injector of claim 1, wherein:

the conformal channel is disposed such that at least one dimension of material of the gas injector surrounding the conformal channel is limited to less than 6mm.

13. The gas injector of claim 1, wherein:

a depth of damage of the gas injector is less than 1 micron.

14. A method of fabricating a ceramic gas injector, the method comprising:

printing, using additive manufacturing equipment, a green part corresponding to the gas injector, the green part comprising a ceramic powder and binder, the green part comprising:

an inlet portion comprising a central bore and a conformal channel disposed in a sidewall, the conformal channel terminating before reaching a top face; and

a collar disposed between the inlet portion and an outlet portion, the conformal channel extending into the collar and terminating before extending into the outlet portion, the conformal channel disposed such that at least one dimension of material of the gas injector surrounding the conformal channel is limited to less than 6mm;

debinding the green part to remove the binder; and

sintering the green part after the debinding to form the gas injector, the gas injector having a depth of damage less than 1 micron.

15. The method of claim 14, wherein printing the green part further comprises:

printing the conformal channel to have a plurality of channel sections each of which extends through the inlet portion and terminates at inlet channel ends before reaching the top face, alternating adjacent pairs of channel sections being connected via the inlet channel ends such that each inlet channel end is separated from an adjacent inlet channel end, and all but one adjacent pair of channel sections not connected via the inlet channel ends being connected via the collar channel ends, and

printing the collar to have ports in a sidewall, the ports connected with the one adjacent pair of channel sections not connected via the inlet channel ends.

16. The method of claim 15, wherein:

the central bore is encircled by secondary inlet holes, and

printing the green part further comprises printing the inlet channel ends and the collar channel ends such that an arc of one of each inlet channel end or each collar channel end is centered angularly around a different one of the secondary inlet holes and an arc of at least another of each inlet channel end or each collar channel end is centered angularly between adjacent ones of the secondary inlet holes.

17. A semiconductor processing system comprising:

a gas manifold configured to supply gasses used during semiconductor processing;

a gas injector comprising:

an inlet portion coupled with the gas manifold and to which the gasses are to be introduced via an inlet hole on an inlet face of the inlet portion, the inlet portion comprising a conformal channel disposed between the inlet hole and a sidewall of the inlet portion, the inlet hole comprising a single inlet central bore and a plurality of secondary inlet holes surrounding the inlet central bore, the secondary inlet holes

equidistant from a center of the inlet central bore, each secondary inlet hole equiangular from each adjacent secondary inlet hole;

an outlet portion from which the gasses are provided from the gas injector via an outlet hole connected to the inlet hole, the outlet hole comprising a single outlet central bore connected with the inlet central bore and a plurality of secondary outlet holes connected with the secondary inlet holes, the secondary outlet holes disposed on a sidewall of the outlet portion; and

a collar disposed between the inlet portion and the outlet portion, the collar having a larger diameter than the inlet portion and the outlet portion, the conformal channel extending into the collar; and

a processing chamber within which a semiconductor wafer is disposed, the gas injector coupled to the processing chamber such that the gasses are provided into the processing chamber from the outlet portion.

18. The system of claim 17, wherein:

the conformal channel has a plurality of channel sections each of which extends through the inlet portion, terminates at inlet channel ends before reaching the inlet face, and also terminates at collar channel ends before reaching the outlet portion.

19. The system of claim 18, wherein:

alternating adjacent pairs of channel sections are connected via the inlet channel ends such that each inlet channel end is separated from an adjacent inlet channel end,

at least some of adjacent pairs of channel sections not connected via the inlet channel ends are connected via the collar channel ends, and

the collar further comprises a sidewall having ports connected with at least one of the adjacent pairs of channel sections not connected via the inlet channel ends.

20. The system of claim 17, further comprising:

a connector integrally formed with the sidewall of the inlet portion, the connector sized to be connected to the gas manifold.