

CLAIMS

What is claimed is:

1. A cooling assembly comprising:
a first subassembly coupled to a showerhead of a substrate processing system,
5 the first subassembly comprising a plurality of passages proximate to and in thermal communication with the showerhead; and
a second subassembly removably coupled to the first subassembly, the second subassembly comprising a plurality of protrusions that align with the plurality of passages, respectively.
- 10 2. The cooling assembly of claim 1 wherein:
the first subassembly is hollow and cylindrical in shape having an inner diameter;
the second subassembly is solid and cylindrical in shape having an outer diameter that is less than the inner diameter; and
the second subassembly is inserted into the first subassembly.
- 15 3. The cooling assembly of claim 1, wherein the plurality of passages surround the plurality of protrusions without contacting the plurality of protrusions, respectively.
4. The cooling assembly of claim 1 wherein the plurality of passages and the plurality of protrusions extend radially from center regions of the first and second subassemblies, respectively.
- 20 5. The cooling assembly of claim 1 wherein the second subassembly comprises an inlet to receive a fluid that flows through the plurality of passages and an outlet to discharge the fluid from the plurality of passages.
6. The cooling assembly of claim 1 wherein:
each passage of the plurality of passages has a first width and a first depth; and
25 each protrusion of the plurality of protrusions has a second width and a second height that are respectively less than the first width and the first depth.
7. The cooling assembly of claim 1 wherein the plurality of passages and the plurality of protrusions have symmetrical shapes.

8. The cooling assembly of claim 1 wherein the plurality of passages and the plurality of protrusions have asymmetrical shapes.
9. The cooling assembly of claim 1 further comprising a plurality of seals that seal points of contact between the plurality of protrusions and the plurality of passages,
5 respectively.
10. The cooling assembly of claim 5 wherein the first and second subassemblies are made of a first material, the cooling assembly further comprising:
an electrically conducting element that is made of a second material having a higher electron affinity than the first material and that is removably disposed in the
10 second subassembly to be in fluid communication with the fluid.
11. The cooling assembly of claim 1 wherein the first subassembly comprises a tubular structure that extends vertically through a center of the first subassembly, that has a first end coupled to a first inlet to receive a process gas, and that has a second end to output the process gas to the showerhead.
- 15 12. The cooling assembly of claim 11 wherein the second subassembly comprises a manifold that surrounds the tubular structure, that is connected to a second inlet to receive a coolant, and that has outlets in fluid communication with the plurality of passages.
- 20 13. The cooling assembly of claim 1 wherein the second subassembly comprises an inlet to receive a purge gas and an outlet to output the purge gas to the showerhead.
14. The cooling assembly of claim 1 further comprising a plurality of fasteners that fasten the second subassembly to the first subassembly.
15. The cooling assembly of claim 1 further comprising a plurality of fasteners that extend through bores in the first and second subassemblies and that fasten the cooling
25 assembly to the showerhead.

16. A cooling assembly coupled to a showerhead of a substrate processing system, the cooling assembly comprising:
- a first subassembly comprising:
 - a first annular flange;
 - 5 a first cylindrical wall extending from the first annular flange to a first base portion enclosing a distal end of the first cylindrical wall, wherein the first base portion is attached to the showerhead of the substrate processing system; and
 - a plurality of passages that are arranged on a first side of the first base portion facing the first annular flange and that extend radially from a first center region
 - 10 of the first base portion towards an outer diameter of the first base portion; and
 - a second subassembly comprising:
 - a second annular flange coupled to the first annular flange;
 - a second cylindrical wall, that extends from the second annular flange to a second base portion and that encloses a distal end of the second cylindrical wall,
 - 15 wherein the first cylindrical wall surrounds the second cylindrical wall; and
 - a plurality of protrusions that are arranged on a second side of the second base portion facing away from the second annular flange, that extend radially from a second center region of the second base portion towards an outer diameter of the second base portion, and that are aligned with the plurality of passages, respectively.
- 20 17. The cooling assembly of claim 16 wherein:
- the first subassembly is made of a first material and further comprises a tubular structure extending perpendicularly from the first center region of the first base portion towards the first annular flange;
 - the second subassembly is made of the first material and further comprises:
 - 25 a first inlet to receive a coolant;
 - a cylindrical manifold that surrounds the tubular structure, that is connected to the first inlet, and that has outlets in fluid communication with the plurality of passages; and
 - an outlet to discharge the coolant from the plurality of passages; and
 - 30 wherein the cooling assembly further comprises an electrically conducting element that is made of a second material having a higher electron affinity than the first material and that is removably disposed in the second subassembly to be in fluid communication with the coolant.

18. An assembly comprising:
a first subassembly comprising:
a first annular flange;
a first cylindrical wall extending from the first annular flange to a first base
5 portion enclosing a distal end of the first cylindrical wall; and
a plurality of passages that are arranged on a first side of the first base
portion facing the first annular flange and that extend radially from a first center region
of the first base portion towards an outer diameter of the first base portion; and
a second subassembly comprising:
10 a second annular flange coupled to the first annular flange;
a second cylindrical wall, that extends from the second annular flange to a
second base portion and that encloses a distal end of the second cylindrical wall,
wherein the first cylindrical wall surrounds the second cylindrical wall; and
a plurality of protrusions that are arranged on a second side of the second
15 base portion facing away from the second annular flange, that extend radially from a
second center region of the second base portion towards an outer diameter of the
second base portion, and that are aligned with the plurality of passages, respectively.
19. The assembly of claim 18 wherein:
the first subassembly further comprises a tubular structure extending
20 perpendicularly from the first center region of the first base portion towards the first
annular flange; and
the second subassembly further comprises:
an inlet to receive a fluid;
a cylindrical manifold that surrounds the tubular structure, that is
25 connected to the inlet, and that has outlets in fluid communication with the plurality of
passages; and
an outlet to discharge the fluid from the plurality of passages.
20. A system comprising:
the assembly of claim 19;
30 an object coupled to a second side of the first base portion that is opposite to the
first side of the first base portion;

a plurality of fasteners that traverse through the assembly and that fasten the object to the second side of the first base portion; and

a fluid supply to supply the fluid to the inlet of the second subassembly,

wherein the fluid includes a coolant to cool the object or a hot fluid to heat the

5 object.