

CLAIMS

1. A pressure regulating apparatus for mitigating pressure increases in a semiconductor wafer conditioning circuit, said pressure regulating apparatus
5 comprising:
a buffer vessel, said buffer vessel comprising an inlet and outlet channel;
wherein
said inlet channel is configured in operation to be in fluid communication
with a higher pressure location of said semiconductor wafer conditioning circuit,
10 and said outlet channel is configured in operation to be in fluid communication
with a lower pressure location;
said inlet channel comprising at least one pressure controlled valve
configured to close said inlet channel during normal operation such that said
buffer vessel is isolated from said higher pressure location of said conditioning
15 circuit and to open said inlet channel in response to said pressure within said
semiconductor conditioning circuit rising above a predetermined level.
2. A pressure regulating apparatus according to claim 1, further comprising a
check valve in said outlet channel for inhibiting flow from said conditioning circuit
20 to said buffer vessel via said outlet channel.
3. A pressure regulating apparatus according to claim 1 or 2, wherein said
pressure controlled valve comprises a mechanical spring loaded valve.
- 25 4. A pressure regulating apparatus according to any preceding claim, said
pressure regulating apparatus further comprising at least one pressure sensor for
sensing a pressure of said conditioning fluid and control circuitry configured to
generate control signals in response to signals received from said at least one
pressure sensor.

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5. A pressure regulating apparatus according to claim 4, wherein said pressure controlled valve comprises a power actuated valve, said control circuitry being configured to generate a control signal to open said power actuated valve
5 in response to said at least one pressure sensor indicating a predetermined pressure level has been reached.

6. A pressure regulating apparatus according to claim 3 or 5, wherein said pressure regulating apparatus is configurable such that said predetermined
10 pressure at which said pressure controlled valve opens can be selected.

7. A pressure regulating apparatus according to any preceding claim, wherein said inlet channel further comprises a second valve, said second valve comprising a power actuated valve configured to be closed to isolate said
15 pressure controlled valve and buffer vessel from said conditioning circuit when not powered and open when powered.

8. A pressure regulating apparatus according to any preceding claim, wherein said buffer vessel comprises at least one further inlet channel in fluid
20 communication with a higher pressure location than a location said outlet channel is in fluid communication with, said at least one further inlet channel comprising a power actuated valve said power actuated valve being closed when powered and open when not powered.

9. A pressure regulating apparatus according to claim 8 when dependent on claim 4, said control circuitry being configured to generate a control signal to open said power actuated valve in said at least one further inlet channel in
25 response to said at least one pressure sensor indicating a predetermined pressure level has been reached.

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10. A pressure regulating apparatus according to claim 8 or 9, said at least one further inlet channel further comprising a check valve for inhibiting flow from said conditioning circuit to said buffer vessel via said at least one further inlet line.

11. A pressure regulating apparatus according to any preceding claim,
5 wherein said pressure regulating apparatus comprises an inlet line for receiving conditioning fluid from a refrigeration system and for supplying said conditioning fluid to said wafer conditioning circuit and a return line for receiving conditioning fluid from said wafer conditioning circuit and returning said fluid to said refrigeration system, said inlet channel being connected to said inlet line.

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12. A pressure regulating apparatus according to claim 11, wherein said outlet channel is connected to said return line.

13. A pressure regulating apparatus according to claim 11 or 12, wherein said
15 pressure regulating apparatus comprises power actuated valves on said inlet and return lines for isolating said pressure regulating apparatus and wafer conditioning circuit from said refrigeration system, said system inlet and outlet power actuated valves being open when powered and closed when not powered.

20 14. A pressure regulating apparatus according to claim 13 when dependent on claim 4, wherein said control circuitry is configured in response to said sensed pressure rising above a further predetermined level that is higher than said predetermined level to close said system inlet valve.

25 15. A pressure regulating apparatus according to claim 14, wherein said control circuitry is configured in response to said sensed pressure rising to a further higher predetermined level to close said system outlet valve.

30 16. A pressure regulating apparatus according to claim 14, wherein said control circuitry is configured after a predetermined time to close said system outlet valve.

17. A pressure regulating apparatus according to any one of claims 13 to 16, wherein said control circuitry is configured in response to said sensed pressure falling to open said system inlet valve.

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18. A pressure regulating apparatus according to any preceding claim, wherein said conditioning fluid comprises a 2-phase mixture of fluids

19. A pressure regulating apparatus according to any preceding claim,
10 wherein a size of said buffer vessel is sufficient to accommodate expansion of said conditioning fluid within said apparatus warming from a low temperature of operation to room temperature.

20. A pressure regulating apparatus according to any preceding claim,
15 wherein said conditioning circuit comprises a plurality of conditioning circuits arranged in parallel for cooling a plurality of semiconductor wafers.

21. A pressure regulating apparatus according to claim 20 when dependent on claim 4, wherein said at least one pressure sensor comprises a plurality of
20 pressure sensors configured to sense pressure within said plurality of conditioning circuits.

22. A pressure regulating apparatus according to any preceding claim when dependent on claim 4, wherein said pressure regulating apparatus comprising a
25 heating mechanism for warming said buffer vessel, said control circuitry being configured to control said heating mechanism to warm said buffer vessel in response to at least one of:

activation of said pressure controlled valve occurring more frequently than a predetermined frequency; and

30 a temperature of said buffer vessel falling below a predetermined level and staying below said predetermined temperature for a predetermined time.

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23. A semiconductor wafer cooling apparatus comprising a refrigeration system and a pressure regulating apparatus according to any preceding claim.

24. A semiconductor wafer cooling apparatus according to any preceding
5 claim wherein said conditioning fluid comprises the refrigerant of said refrigeration system.

25. A method of providing pressure protection to a semiconductor wafer conditioning circuit, said method comprising:
10 connecting an inlet channel and outlet channel of a pressure regulating apparatus according to a first aspect of the present invention to a semiconductor wafer conditioning circuit such that they are in fluid communication with an inlet and outlet channel of a semiconductor wafer conditioning circuit which channels are configured to receive conditioning fluid from and return conditioning fluid to a
15 refrigeration system.