

CLAIMS

1. An apparatus for processing substrates, the apparatus comprising:
 - (a) a plasma etch chamber comprising a showerhead and a pedestal for holding a substrate comprising silicon nitride;
 - (b) at least one outlet for coupling to a vacuum;
 - (c) a solid non-functional silicon source; and
 - (d) a plasma generator.
2. The apparatus of claim 1, wherein the solid non-functional silicon source comprises two or more silicon sources.
3. The apparatus of claim 1, wherein the solid non-functional silicon source is disposed upstream of the substrate.
4. The apparatus of claim 1, wherein the solid non-functional silicon source is disposed at or near the showerhead of the plasma etch chamber.
5. The apparatus of claim 1, wherein the plasma generator is a remote plasma generator and the solid non-functional silicon source is disposed in the remote plasma generator.
6. The apparatus of claim 1, wherein the solid non-functional silicon source is disposed between the substrate and the showerhead of the plasma etch chamber.
7. The apparatus of claim 1, wherein the solid non-functional silicon source is attached to a wall of the plasma generator.
8. The apparatus of claim 1, wherein the solid non-functional silicon source is a ring.
9. The apparatus of claim 1, wherein the solid non-functional silicon source is a rod.
10. The apparatus of claim 1, wherein the solid non-functional silicon source is a silicon-containing compound selected from the group consisting of quartz, silicon, silicon germanium, silicon carbide, and silicon oxide.

11. An apparatus for processing substrates, the apparatus comprising:
 - (a) a plasma etch chamber comprising a showerhead and a pedestal for holding a substrate comprising silicon nitride;
 - (b) at least one outlet for coupling to a vacuum;
 - (c) a solid non-functional silicon source;
 - (d) a plasma generator; and
 - (e) a controller for controlling operations in the apparatus, comprising machine-readable instructions for:
 - causing introduction of a fluorinating gas to the plasma generator; and
 - causing ignition of a plasma to form fluorine-containing etching species in the plasma etch chamber; and
 - causing providing of additional silicon to the plasma from a fluidic silicon source.
12. The apparatus of claim 11, wherein the fluorinating gas is selected from the group consisting of F_2 , SF_6 , CF_4 , CHF_3 , CH_2F_2 , NF_3 , and combinations thereof.
13. The apparatus of claim 11, wherein the fluidic silicon source is a non-fluorinating fluidic silicon source.
14. The apparatus of claim 13, wherein the non-fluorinating fluidic silicon source is a silicon-containing compound selected from the group consisting of silane, disilane, tetraethyl orthosilicate, and tetramethyl silane.
15. The apparatus of claim 13, wherein the non-fluorinating fluidic silicon source is a silicon-containing gas and wherein the machine-readable instructions further comprise instructions for causing the silicon-containing gas to be provided at a flow rate of less than about 10% of total flow rate of gases flowed into the plasma etch chamber.
16. The apparatus of claim 11, wherein the fluidic silicon source is a gaseous silicon source.
17. The apparatus of claim 11, wherein the fluidic silicon source is a liquid silicon source.

18. The apparatus of claim 11, wherein the machine-readable instructions further comprise instructions for introducing the fluidic silicon source at a flow rate of at least about 0.5% of a total flow of gases by volume introduced to the plasma.
19. The apparatus of claim 11, wherein the machine-readable instructions further comprise causing introduction of one or more oxidant gases.
20. The apparatus of claim 19, wherein the one or more oxidant gases is selected from the group consisting of oxygen, nitrogen, nitrous oxide, and nitric oxide.
21. A method of etching silicon nitride on a substrate, the method comprising:
 - (a) introducing a fluorinating gas to a plasma generator and igniting a plasma to form fluorine-containing etching species;
 - (b) providing silicon to the plasma from a solid silicon source, the solid silicon source having only the function of providing silicon to the plasma; and
 - (c) exposing silicon nitride on a substrate to the fluorine-containing etching species to selectively etch the silicon nitride relative to other silicon-containing materials on the substrate.
22. The method of claim 21, wherein the solid silicon source is provided to the plasma upstream of the substrate.
23. The method of claim 21, wherein the solid silicon source is provided to the plasma in a remote plasma generator.
24. The method of claim 21, wherein the solid silicon source is provided to the plasma between the substrate and a showerhead of a chamber housing the substrate.
25. The method of claim 21, wherein the solid silicon source is provided to the plasma at or near a showerhead of a chamber housing the substrate.
26. The method of claim 21, wherein the solid silicon source comprises two or more silicon sources.

27. The method of claim 21, wherein the solid silicon source is attached to a wall of the plasma generator.
28. The method of claim 21, wherein the fluorinating gas is selected from the group consisting of F₂, SF₆, CF₄, CHF₃, CH₂F₂, NF₃, and combinations thereof.
29. The method of claim 21, wherein the solid silicon source is a silicon-containing compound selected from the group consisting of quartz, silicon, silicon germanium, silicon carbide, and silicon oxide.
30. The method of claim 21, wherein the solid silicon source is a ring.
31. The method of claim 21, wherein the solid silicon source is a rod.
32. The method of claim 21, wherein (b) further comprises providing additional silicon to the plasma from a fluidic silicon source.
33. The method of claim 32, wherein the fluidic silicon source is a non-fluorinating fluidic silicon source.
34. The method of claim 33, wherein the non-fluorinating fluidic silicon source is selected from the group consisting of silane, disilane, tetraethyl orthosilicate, and tetramethyl silane.
35. The method of claim 33, wherein the non-fluorinating fluidic silicon source is a silicon-containing gas and a flow rate of the silicon-containing gas to a process chamber housing the substrate is less than about 10% of a total flow rate of gases flowed into the process chamber.
36. The method of claim 32, wherein at least about 0.5% of a total flow of gases by volume introduced to the plasma is the fluidic silicon source.
37. The method of claim 32, wherein the fluidic silicon source is a gaseous silicon source.
38. The method of claim 32, wherein the fluidic silicon source is a liquid silicon source.

39. The method of claim 32, wherein the fluorine-containing etching species reacts with the fluidic silicon source to deplete an amount of atomic fluorine present in the plasma.
40. The method of any of claims 21-32, further comprising introducing one or more oxidant gases during (b).