

CLAIMS

1. A method for selectively etching silicon oxide, comprising:
providing a surface reaction phase, comprising:
 flowing a surface reaction gas comprising hydrogen, nitrogen and fluorine containing components to form silicon oxide into a compound comprising silicon, hydrogen, nitrogen, and fluorine;
 forming the surface reaction gas into a plasma; and
 stopping the flow of the surface reaction gas;
a plasma heating phase; and
wet treating the surface to remove the compound.
2. The method, as recited in claim 1, wherein the surface reaction gas comprises:
 NF_3 or HF ; and
 H_2 , N_2 or NH_3 .
3. The method, as recited in claim 2, wherein the compound is an amine containing salt.
4. The method, as recited in claim 3, wherein the plasma heating phase comprises:
 flowing a heating gas, wherein the heating gas comprises H_2 , N_2 or NH_3 , and wherein the heating gas is NF_3 and HF free;
 forming the heating gas into a plasma; and
 stopping the flow of the heating gas.
5. The method, as recited in claim 4, wherein the surface reaction gas comprises NF_3 and NH_3 and wherein the heating gas comprises NH_3 and is free of NF_3 .
6. The method, as recited in claim 5, wherein the providing the surface reaction phase and providing the plasma heating phase make up a dry treatment, wherein the dry treatment is repeated cyclically a plurality of times.
7. The method, as recited in claim 6, wherein the dry treatment is performed at a pressure of at least 5 mTorr.

8. The method, as recited in claim 7, wherein the surface reaction gas and the heating gas both further comprise flowing a noble gas.
9. The method, as recited in claim 8, wherein a continuous plasma is maintained during the cyclically repeated dry treatment.
10. The method, as recited in claim 1, wherein the plasma heating phase, comprises:
flowing a heating gas, wherein the heating gas comprises H_2 , N_2 or NH_3 , and wherein the heating gas is NF_3 and HF free;
forming the heating gas into a plasma; and
stopping the flow of the heating gas.
11. The method, as recited in claim 1, wherein the surface reaction gas comprises NF_3 and NH_3 and wherein the heating gas comprises NH_3 and is free of NF_3 .
12. The method, as recited in claim 1, wherein the providing the surface reaction phase and providing the plasma heating phase make up a dry treatment, wherein the dry treatment is repeated cyclically a plurality of times.
13. The method, as recited in claim 1, wherein providing the surface reaction and wet treating the surface are cyclically repeated a plurality of times.
14. The method, as recited in claim 13, wherein the wet treating uses a hydrophobic solvent that is able to dissolve the compound without oxidizing silicon.
15. The method, as recited in claim 1, wherein the wet treating uses a solvent that is able to dissolve the compound without oxidizing silicon.
16. A method for selectively etching silicon oxide, comprising
providing a dry treatment, comprising a plurality of cycles, wherein each cycle comprises:
providing a surface reaction phase, comprising:
flowing a surface reaction gas comprising NF_3 or HF and further comprising H_2 , N_2 , or NH_3 to form silicon oxide into a compound comprising silicon,

hydrogen, nitrogen, and fluorine;
forming the surface reaction gas into a plasma; and
stopping the flow of the surface reaction gas; and
plasma heating the surface to volatilize the compound, comprising:
flowing a heating gas, wherein the heating gas comprises noble gases,
H₂, N₂ or NH₃, and wherein the heating gas is NF₃ and HF free;
forming the heating gas into a plasma; and
stopping the flow of the heating gas; and
wet treating the surface to remove the compound.

17. The method, as recited in claim 16, wherein the surface reaction gas comprises NF₃ and NH₃ and wherein the heating gas comprises NH₃ and is free of NF₃.

18. The method, as recited in claim 17, wherein the dry treatment is performed at a pressure of at least 5 mTorr.