

- maintaining the substrate at a temperature ranging from approximately -196°C to approximately 500°C;
- maintaining the substrate at a temperature ranging from approximately -120°C to approximately 300°C;
- maintaining the substrate at a temperature ranging from approximately -100°C to approximately 50°C;
- maintaining the substrate at a temperature ranging from approximately -10°C to approximately 40°C; and
- measuring the activated iodine-containing etching compound by Quadrupole mass spectrometer, optical emission spectrometer, FTIR, or other radical/ion measurement tool.

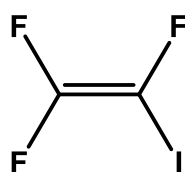
[0010a] In one aspect, there is provided a method of forming a patterned structure, the method comprising introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a silicon-containing film on a substrate, wherein the iodine-containing etching compound is selected from the group consisting of C₂H₂FI (1-fluoro-1-iodoethene, CAS No.: 420-28-0), C₃HF₆I, C₃H₃F₂I, C₃H₄FI, C₃H₅F₂I, C₃H₆FI, C₂HFI₂, C₂H₂F₂I₂, C₂H₃FI₂, C₂F₂I₂, C₃HF₃I₂, C₃HF₅I₂, C₃H₂F₄I₂, C₃H₃F₃I₂, C₃H₄F₂I₂ and C₃H₅FI₂; introducing an inert gas into the reaction chamber; and activating a plasma to produce an activated iodine-containing etching compound capable of etching the silicon-containing film from the substrate to form the patterned structure; and removing volatile by-products from the reaction chamber, wherein the activated iodine-containing etching compound reacts with the silicon-containing film to form the volatile by-products.

[0010b] In another aspect, there is provided a method of minimizing damage to a patterned mask layer while forming a via or trench in a substrate, the method comprising introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a substrate having a silicon-containing film disposed thereon and a patterned mask layer disposed on the silicon-containing layer, wherein the iodine-containing etching compound is selected from the group consisting of C₂H₂FI (1-fluoro-1-iodoethene, CAS No.: 420-28-0), C₃HF₆I, C₃H₃F₂I, C₃H₄FI, C₃H₅F₂I, C₃H₆FI, C₂HFI₂, C₂H₂F₂I₂, C₂H₃FI₂, C₂F₂I₂, C₃HF₃I₂, C₃HF₅I₂, C₃H₂F₄I₂, C₃H₃F₃I₂, C₃H₄F₂I₂ and C₃H₅FI₂; introducing an inert gas into the reaction chamber; and etching the silicon-containing film from the substrate to form the via or trench by

activating a plasma to form an activated iodine-containing etching compound.

[0011] Also disclosed are iodine-containing etching compounds having the formula $C_aH_xF_yI_z$, wherein $a=1-3$, $x=0-6$, $y=1-7$, $z=1-2$, $x+y+z=4$ when $a=1$, $x+y+z=4$ or 6 when $a=2$, and $x+y+z=6$ or 8 when $a=3$. The disclosed iodine-containing etching compounds include one or more of the following aspects:

- the iodine-containing etching compound having the formula $CH_xF_yI_z$, wherein x is 0-2, y is 1-3, z is 1-2, and $x+y+z=4$;
- the iodine-containing etching compound being CF_3I ;
- the iodine-containing etching compound being CF_2I_2 ;
- the iodine-containing etching compound having the formula $CH_xF_yI_z$, wherein x is 1-2, y is 1-2, z is 1-2, and $x+y+z=4$;
- the iodine-containing etching compound being CHF_2I ;
- the iodine-containing etching compound being CH_2FI ;
- the iodine-containing etching compound being CHF_2I_2 ;
- the iodine-containing etching compound having the formula $C_2H_xF_yI_z$, wherein x is 0-2, y is 1-3, z is 1-2, and $x+y+z=4$;
- the iodine-containing etching compound being C_2F_3I and having the structure:



- the iodine-containing etching compound having the formula $C_2H_xF_yI_z$, wherein x is 1-2, y is 1-2, z is 1-2, and $x+y+z=4$;

What is claimed is:

1. A method of forming a patterned structure, the method comprising:
introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a silicon-containing film on a substrate, wherein the iodine-containing etching compound is selected from the group consisting of C₂H₂FI (1-fluoro-1-iodoethene, CAS No.: 420-28-0), C₃HF₆I, C₃H₃F₂I, C₃H₄FI, C₃H₅F₂I, C₃H₆FI, C₂HFI₂, C₂H₂F₂I₂, C₂H₃FI₂, C₂F₂I₂, C₃HF₃I₂, C₃HF₅I₂, C₃H₂F₄I₂, C₃H₃F₃I₂, C₃H₄F₂I₂ and C₃H₅FI₂;
introducing an inert gas into the reaction chamber; and
activating a plasma to produce an activated iodine-containing etching compound capable of etching the silicon-containing film from the substrate to form the patterned structure; and
removing volatile by-products from the reaction chamber, wherein the activated iodine-containing etching compound reacts with the silicon-containing film to form the volatile by-products.
2. The method of claim 1, wherein the iodine-containing etching compound is C₃HF₆I.
3. The method of claim 1, further comprising introducing an oxidizer into the reaction chamber, wherein the oxidizer is selected from the group consisting of O₂, CO, CO₂, NO, N₂O and NO₂.
4. The method of claim 1, further comprising introducing an etch gas into the reaction chamber, wherein the etch gas is selected from the group consisting of cC₄F₈, cC₅F₈, C₄F₆, CF₄, CH₃F, CF₃H, CH₂F₂, COS, F-C≡N, CS₂, SO₂, trans-1,1,1,4,4,4-hexafluoro-2-butene (*trans*-C₄H₂F₆), cis-1,1,1,4,4,4-hexafluoro-2-butene (*cis*-C₄H₂F₆), hexafluoroisobutene (C₄H₂F₆), trans-1,1,2,2,3,4-hexafluorocyclobutane (*trans*-C₄H₂F₆), 1,1,2,2,3-pentafluorocyclobutane (C₄H₃F₅), 1,1,2,2-tetrafluorocyclobutane (C₄H₄F₄), and cis-1,1,2,2,3,4-hexafluorocyclobutane (*cis*-C₄H₂F₆).

5. The method of claim 1, wherein the silicon-containing film comprises a layer of silicon oxide, silicon nitride, polysilicon, crystalline silicon, low-*k* SiCOH, SiOCN, SiON, Si_aO_bH_cC_dN_e, where $a > 0$; b, c, d and $e \geq 0$, or combinations thereof.
6. The method of any one of claims 1 to 5, wherein the silicon-containing film is selectively etched from an amorphous carbon layer or a photoresist layer.
7. The method of any one of claims 1 to 5, wherein the silicon oxide layer is selectively etched from a silicon nitride, polysilicon or amorphous carbon layer.
8. The method of any one of claims 1 to 5, wherein the method produces an aperture in the silicon-containing film having an aspect ratio between 10:1 and 200:1.
9. The method of any one of claims 1 to 5, wherein the method produces an aperture in the silicon-containing film having a diameter ranging from 5 nm to 100 nm.
10. A method of minimizing damage to a patterned mask layer while forming a via or trench in a substrate, the method comprising:
 - introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a substrate having a silicon-containing film disposed thereon and a patterned mask layer disposed on the silicon-containing layer, wherein the iodine-containing etching compound is selected from the group consisting of C₂H₂FI (1-fluoro-1-iodoethene, CAS No.: 420-28-0), C₃HF₆I, C₃H₃F₂I, C₃H₄FI, C₃H₅F₂I, C₃H₆FI, C₂HFI₂, C₂H₂F₂I₂, C₂H₃FI₂, C₂F₂I₂, C₃HF₃I₂, C₃HF₅I₂, C₃H₂F₄I₂, C₃H₃F₃I₂, C₃H₄F₂I₂ and C₃H₅FI₂;
 - introducing an inert gas into the reaction chamber; and
 - etching the silicon-containing film from the substrate to form the via or trench by activating a plasma to form an activated iodine-containing etching compound.
11. The method of claim 10, wherein the iodine-containing etching compound is C₃HF₆I.

12. The method of any one of claims 10 to 11, wherein the activated iodine-containing etching compound produces iodine ions that strengthen the patterned mask layer.

13. A method of reinforcing a patterned mask layer while forming a via or trench in a substrate, the method comprising:

introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a substrate having a silicon-containing film disposed thereon and a patterned mask layer disposed on the silicon-containing layer, wherein the iodine-containing etching compound is selected from the group consisting of C_2H_2FI (1-fluoro-1-iodoethene, CAS No.: 420-28-0), C_3HF_6I , $C_3H_3F_2I$, C_3H_4FI , $C_3H_5F_2I$, C_3H_6FI , C_2HFI_2 , $C_2H_2F_2I_2$, $C_2H_3FI_2$, $C_2F_2I_2$, $C_3HF_3I_2$, $C_3HF_5I_2$, $C_3H_2F_4I_2$, $C_3H_3F_3I_2$, $C_3H_4F_2I_2$ and $C_3H_5FI_2$;

introducing an inert gas into the reaction chamber; and

implanting an I ion from the iodine-containing etching compound into the patterned mask while etching the silicon-containing film from the substrate to form the via or trench by activating a plasma to form an activated iodine-containing etching compound.

14. The method of claim 13, wherein the iodine-containing etching compound is C_3HF_6I .

15. The method of any one of claims 13 to 14, wherein the activated iodine-containing etching compound produces iodine ions that strengthen the patterned mask layer.