

- 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 $C_2H_3F_2I$, C_2H_4FI , $C_2F_4I_2$, C_3HF_6I , $C_3H_2F_5I$, $C_3H_3F_4I$, and $C_3H_4F_3I$; 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.

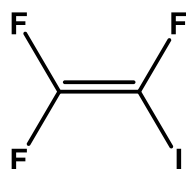
[0010b] In another aspect, there is provided a method of minimizing damage to a patterned mask layer while forming a via or trench in a substrate, the method comprising introducing a vapor of an iodine-containing etching compound into a reaction chamber containing a substrate having a silicon-containing film disposed thereon and a patterned mask layer disposed on the silicon-containing film, wherein the iodine-containing etching compound is selected from the group consisting of $C_2H_3F_2I$, or C_2H_4FI ; 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.

[0010c] In yet another aspect, there is provided 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 film, wherein the

iodine-containing etching compound is selected from the group consisting of $C_2H_3F_2I$, or C_2H_4FI ; 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

[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 $CHFI_2$;
- 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 $C_2H_3F_2I$, C_2H_4FI , $C_2F_4I_2$, C_3HF_6I , $C_3H_2F_5I$, $C_3H_3F_4I$, and $C_3H_4F_3I$;
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.
2. The method of claim 1, further comprising 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.
3. The method of claim 2, further comprising introducing an oxidizer into the reaction chamber.
4. The method of claim 3, wherein the oxidizer is selected from the group consisting of O_2 , O_3 , CO , CO_2 , NO , N_2O , NO_2 , and combinations thereof.
5. The method of claim 2, further comprising introducing an etch gas into the reaction chamber.
6. The method of claim 5, wherein the etch gas is selected from the group consisting of cC_4F_8 , cC_5F_8 , C_4F_6 , CF_4 , CH_3F , CF_3H , CH_2F_2 , COS , $F-C\equiv N$, CS_2 , SO_2 , *trans*-1,1,1,4,4,4-hexafluoro-2-butene (*trans*- $C_4H_2F_6$), *cis*-1,1,1,4,4,4-hexafluoro-2-butene (*cis*- $C_4H_2F_6$), hexafluoroisobutene ($C_4H_2F_6$), *trans*-1,1,2,2,3,4-hexafluorocyclobutane (*trans*- $C_4H_2F_6$), 1,1,2,2,3-pentafluorocyclobutane ($C_4H_3F_5$), 1,1,2,2-tetrafluorocyclobutane ($C_4H_4F_4$), and *cis*-1,1,2,2,3,4-hexafluorocyclobutane (*cis*- $C_4H_2F_6$).

7. The method of claim 1, wherein the inert gas is selected from the group consisting of He, Ar, Xe, Kr, Ne, N₂ or combinations thereof.
8. The method of any claims from 1 to 7, 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.
9. The method of any claims from 1 to 7, wherein the silicon-containing film is selectively etched from an amorphous carbon layer or a photoresist layer.
10. The method of claim 8, wherein the silicon oxide layer is selectively etched from a silicon nitride, polysilicon or amorphous carbon layer.
11. The method of any claims from 1 to 7, wherein the method produces an aperture in the silicon-containing film having an aspect ratio between 10:1 and 200:1.
12. 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 film, wherein the iodine-containing etching compound is selected from the group consisting of C₂H₃F₂I, or C₂H₄FI;
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.
13. The method of claim 12, wherein the activated iodine-containing etching compound produces iodine ions that strengthen the patterned mask layer.

14. 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 film, wherein the iodine-containing etching compound is selected from the group consisting of $C_2H_3F_2I$, or C_2H_4FI ;

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.