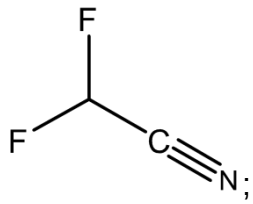
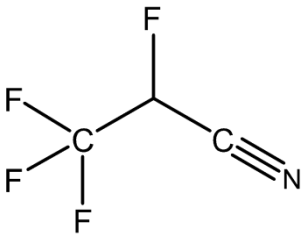
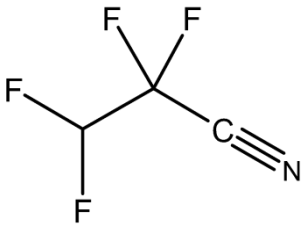
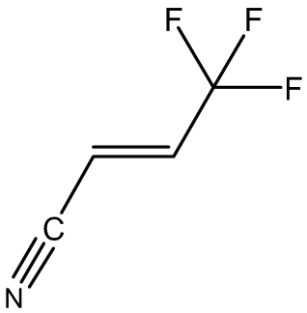
- maintaining the substrate at a temperature ranging from approximately -10°C to approximately 40°C; and
- measuring the activated nitrogen containing etching compound by Quadrupole mass spectrometer, optical emission spectrometer, FTIR, or other radical/ion measurement tool.

[0011a] In one aspect, there is provided a method of depositing an etch-resistant polymer layer on a substrate, the method comprising introducing a vapor of an organofluorine compound into a reaction chamber containing a substrate, the organofluorine compound having a formula selected from the group consisting of N≡C–R^1, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11, and c=1-5; (N≡C-)-(R^2)-(-C≡N), wherein R^2 has the formula $H_aF_bC_c$ with a=0-11, b=1-11, and c=1-5; and $R^1_x[-C=N(R^2_z)]_y$, wherein x=1-2, y=1-2, z=0-1, x+z=1-3, and each R^1 and R^2 independently has the formula $H_aF_bC_c$ with a=0-11, b=0-11, and c=0-5; and plasma activating an organofluorine compound to form the etch-resistant polymer layer on the substrate, wherein the organofluorine compound having a purity ranging from 95% to 99.999% by volume and comprising between 10 parts per trillion to 5% by volume water vapor impurities.

[0011b] In another aspect, there is provided a method of depositing an N-containing polymer passivation layer on a substrate, the method comprising introducing a vapor of an organofluorine compound into a reaction chamber containing a substrate, the organofluorine having a formula selected from the group consisting of N≡C–R^1, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11, and c=1-5; (N≡C-)-(R^2)-(-C≡N), wherein R^2 has the formula $H_aF_bC_c$ with a=0-11, b=1-11, and c=1-5; and $R^1_x[-C=N(R^2_z)]_y$, wherein x=1-2, y=1-2, z=0-1, x+z=1-3, and each R^1 and R^2 independently has the formula $H_aF_bC_c$ with a=0-11, b=0-11, and c=0-5; and producing fragments of the organofluorine compound by activating a plasma to form the N-containing polymer passivation layer on the substrate, wherein the organofluorine compound having a purity ranging from 95% to 99.999% by volume and comprising between 10 parts per trillion to 5% by volume water vapor impurities**.**

[0012] Also disclosed are nitrogen containing etching compound comprising an organofluorine compound having a C≡N or C=N functional group. The disclosed nitrogen containing etching compounds include one or more of the following aspects:

- the organofluorine compound containing a C≡N functional group ;

- the organofluorine compound having the formula $N{\equiv}C–R^1$, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11, and c=1-5;
- the organofluorine compound being difluoroacetonitrile (C_2HF_2N) having the formula ;
- the organofluorine compound being 2,3,3,3-tetrafluoropropionitrile (C_3HF_4N) having the formula ;
- the organofluorine compound being 2,2,3,3-tetrafluoropropionitrile (C_3HF_4N) having the formula ;
- the organofluorine compound being 4,4,4-Trifluorocrotono-nitrile ($C_4H_2F_3N$) having the formula ;

What is claimed is:

1. A method of depositing an etch-resistant polymer layer on a substrate, the method comprising:

introducing a vapor of an organofluorine compound into a reaction chamber containing a substrate, the organofluorine compound having a formula selected from the group consisting of N≡C–R^1, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11, and c=1-5; (N≡C-)-(R^2)-(-C≡N), wherein R^2 has the formula $H_aF_bC_c$ with a=0-11, b=1-11, and c=1-5; and R^1_x[-C=N(R^2_z)]$_y$, wherein x=1-2, y=1-2, z=0-1, x+z=1-3, and each R^1 and R^2 independently has the formula $H_aF_bC_c$ with a=0-11, b=0-11, and c=0-5; and

plasma activating an organofluorine compound to form the etch-resistant polymer layer on the substrate,

wherein the organofluorine compound having a purity ranging from 95% to 99.999% by volume and comprising between 10 parts per trillion to 5% by volume water vapor impurities.

2. The method of claim 1, wherein the organofluorine compound has the formula: N≡C–R^1, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11 and c=1-5, or (N≡C-)-(R^2)-(-C≡N), wherein R^2 is a functional group having the formula $H_aF_bC_c$ with a=0-11, b=1-11, and c=1-5.

3. The method of claim 1, wherein the organofluorine compound has the formula: R^1_x[-C=N(R^2_z)]$_y$, wherein x=1-2, y=1-2, z=0-1, x+z=1-3, and each R^1 and R^2 independently has the formula $H_aF_bC_c$ with a=0-11, b=0-11, and c=0-5.

4. The method of claim 1, wherein the organofluorine compound is selected from the group consisting of 2,2,3,3-tetrafluoropropionitrile, 2,3,3,3-tetrafluoropropionitrile (C_3HF_4N), difluoroacetonitrile (C_2HF_2N), trifluoroacetonitrile (C_2F_3N); Hexafluoroacetone imine (C_3HF_6N); 4,4,4-Trifluorocrotono-nitrile, 3,3,3-Trifluoropropionitrile, fluoroacetonitrile, octafluorohexane-1,6-dinitrile, 1,1-bis(trifluoromethyl)-2,2-dicyanoethylene, N,1,1,1,3,3,3-heptafluoro-propanamine, and 1,1,1,6,6,6-Hexafluoro-3-azahex-3-ene.

5. The method of claim 1, wherein the organofluorine compound is 2,3,3,3-tetrafluoropropionitrile (C_3HF_4N).

6. The method of claim 1, wherein the organofluorine compound is difluoroacetonitrile (C_2HF_2N).

7. The method of claim 1, wherein the etch-resistant polymer layer forms a N-containing polymer passivation layer on sidewalls of a pattern etch structure.

8. The method of claim 7, wherein the pattern etch structure has an aspect ratio ranging from 1:1 to 50:1.

9. The method of claim 7, wherein the pattern etch structure has an aspect ratio ranging from 10:1 to 200:1.

10. The method of claim 7, wherein the N-containing polymer passivation layer prevents ions and radicals from etching the sidewalls.

11. The method of claim 7, wherein the etch-resistant polymer layer results in the pattern etch structure having a vertical profile that is straight with no bowing.

12. The method of any one of claims 1 to 11, further comprising removing the etch-resistant polymer layer using dry or wet etch chemistries.

13. The method of any one of claims 1 to 11, further comprising introducing an inert gas into the reaction chamber.

14. The method of claim 13, wherein the inert gas is selected from the group consisting of He, Ar, Xe, Kr, Ne, N_2, and combinations thereof.

15. A method of depositing an N-containing polymer passivation layer on a substrate, the method comprising:

introducing a vapor of an organofluorine compound into a reaction chamber containing a substrate, the organofluorine having a formula selected from the group

consisting of N≡C–R^1, wherein R^1 has the formula $H_aF_bC_c$ and a=1-11, b=1-11, and c=1-5; (N≡C-)-(R^2)-(-C≡N), wherein R^2 has the formula $H_aF_bC_c$ with a=0-11, b=1-11, and c=1-5; and $R^1_x[-C=N(R^2_z)]_y$, wherein x=1-2, y=1-2, z=0-1, x+z=1-3, and each R^1 and R^2 independently has the formula $H_aF_bC_c$ with a=0-11, b=0-11, and c=0-5; and

producing fragments of the organofluorine compound by activating a plasma to form the N-containing polymer passivation layer on the substrate,

wherein the organofluorine compound having a purity ranging from 95% to 99.999% by volume and comprising between 10 parts per trillion to 5% by volume water vapor impurities.

16. The method of claim 15, wherein the organofluorine compound is selected from the group consisting of 2,2,3,3-tetrafluoropropionitrile, 2,3,3,3-tetrafluoropropionitrile (C_3HF_4N), difluoroacetonitrile (C_2HF_2N), trifluoroacetonitrile (C_2F_3N); Hexafluoroacetone imine (C_3HF_6N); 4,4,4-Trifluorocrotono-nitrile, 3,3,3-Trifluoropropionitrile, fluoroacetonitrile, octafluorohexane-1,6-dinitrile, 1,1-bis(trifluoromethyl)-2,2-dicyanoethylene, N,1,1,1,3,3,3-heptafluoro-propanamine, and 1,1,1,6,6,6-Hexafluoro-3-azahex-3-ene.

17. The method of claim 15 or 16, further comprising removing the N-containing polymer passivation layer using dry or wet etch chemistries.

18. The method of claim 15 or 16, further comprising introducing an inert gas into the reaction chamber.

19. The method of claim 18, wherein the inert gas is selected from the group consisting of He, Ar, Xe, Kr, Ne, N_2, and combinations thereof.