What is claimed is:

1. A method for etching silicon-containing films, the method comprising the steps of:

introducing a vapor of a nitrogen containing etching compound into a reaction chamber containing a silicon-containing film on a substrate, wherein the nitrogen containing etching compound comprises an 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, 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;

introducing an inert gas into the reaction chamber; and

activating a plasma to produce an activated nitrogen containing etching compound capable of etching the silicon-containing film from the substrate

wherein the nitrogen containing etching compound has a purity ranging from approximately 95% to approximately 99.999% by volume; and comprises between approximately 10 parts per trillion to approximately 5% by volume water vapor impurities.

2. The method of claim 1, further comprising removing volatile by-products from the reaction chamber, wherein the activated nitrogen containing etching compound reacts with the silicon-containing film to form the volatile by-products.

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

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

5. The method of claim 2, wherein the organofluorine compound containing the C=N functional groups 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.

6. 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), 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.

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

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

9. The method of any one of claims 1 to 8, further comprising introducing an oxidizer into the reaction chamber.

10. The method of any one of claims 1 to 8, 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 ≥ 0, or combinations thereof.

11. The method of claim 10, wherein the silicon-containing film is selectively etched from an amorphous carbon layer or a photoresist layer.

12. The method of claim 10, wherein the silicon oxide layer is selectively etched from a silicon nitride, polysilicon or amorphous carbon layer.

13. The method of claim 9, wherein the method produces an aperture in the silicon-containing film having an aspect ratio between approximately 10:1 and approximately 200:1.