CLAIMS:

1. A method for etching features in a plurality of silicon based bilayers forming a stack on a wafer in a plasma processing chamber, comprising:

flowing an oxygen free main etch gas into the plasma processing chamber wherein the main etch gas comprises a hydrofluorocarbon and $NF_3$;

forming the main etch gas into a plasma, while providing a first pressure between 30 mtorr to 60 mtorr;

maintaining a wafer temperature of less than $100^0$C.;

ramping the pressure to a second pressure less than the first pressure as the plasma etches through a plurality of the plurality of silicon based bilayers; and

stopping the flow of the main etch gas after a first plurality of the plurality of bilayers is etched.

2. The method, as recited in claim 1, wherein the forming the main etch gas into a plasma comprises providing an inductively coupled power to a upper power source placed on a first side of the wafer and providing a bias power to a bottom electrode on a second side of the wafer opposite the first side of the wafer wherein the bias power has a frequency between 100 kHz and 1 MHz.

3. The method, as recited in claim 1, further comprising an over etch after stopping the flow of the main etch gas for etching remaining unetched bilayers, wherein the over etch comprises:

flowing an over etch gas which is more polymerizing than the main etch gas and comprising $NF_3$ into the plasma processing chamber;

forming the over etch gas into a plasma;

stopping the flow of the over etch gas; and

wherein the over etch further comprises increasing the wafer temperature from the main etch.

4. The method, as recited in claim 3, wherein the over etch further comprises lowering the pressure from the main etch.

5. The method, as recited in claim 1, wherein each silicon based bilayer comprises a polysilicon layer and a silicon oxide layer.

6. The method, as recited in claim 1, wherein the over etch is performed until an etch stop layer is reached.

7. The method, as recited in claim 1 wherein the bilayers comprise alternating layers of amorphous silicon and silicon oxide or the bilayers comprise alternating layers of silicon nitride and silicon oxide.

8. The method, as recited in claim 1 wherein the over etch gas further comprises $CH_3F$, and $CH_4$ and wherein said over etch includes modulating the quality of a deposited polymer layer by adjusting a $CH_3F$ to $CH_4$ ratio in the over etch gas.

9. A method for etching wafer bilayers in a plasma processing chamber, the method comprising

arranging a wafer in a plasma processing chamber wherein the wafer includes at least 16 silicon based bilayers including a first plurality of twelve silicon based bilayers;

flowing a main etch gas into the plasma processing chamber;

forming the main etch gas into a plasma, while providing a first pressure;

maintaining a wafer temperature of less than $20^0$C.;

ramping the pressure to a second pressure that is less than the first pressure as the plasma etches through the at least 12 silicon based bilayers wherein said ramping provides at least six different pressures over which the 12 bilayers are etched; and

stopping the flow of the main etch gas after a first plurality of the plurality of bilayers is etched.

10. The method recited in claim 9, wherein

each silicon based bilayer comprises a polysilicon layer and a silicon oxide layer;

the main etch gas comprises a hydrofluorocarbon and $NF_3$; and

the plasma is formed by providing an inductively coupled power to a upper power source placed on a first side of the wafer and providing a bias power to a bottom electrode on a second side of the wafer opposite the first side of the wafer, such that

the bias power has a frequency between 100 kHz and 1 MHz, and

a first pressure between 30 mtorr to 60 mtorr is provided, and

the wafer temperature is less than $10^0$ C.

11. The method, as recited in claim 10, wherein the etch features are vias with an aspect ratio of at least 20:1.

12. The method, as recited in claim 11, further comprising an over etch after stopping the flow of the main etch gas for etching remaining unetched bilayers, wherein the over etch comprises:

flowing an over etch gas which is more polymerizing than the main etch gas and comprising $NF_3$ into the plasma processing chamber;

forming the over etch gas into a plasma; and

stopping the flow of the over etch gas.

13. The method, as recited in claim 12, wherein the over etch further comprises increasing the wafer temperature from the main etch.

14. The method, as recited in claim 13, wherein the over etch further comprises lowering the pressure from the main etch.

15. The method, as recited in claim 1 wherein the bilayers comprise a polysilicon layer and silicon oxide layer.

## CLAIMS

What is claimed is:

1. A method for etching features in a plurality of silicon based bilayers forming a stack on a wafer in a plasma processing chamber, comprising:

flowing a main etch gas into the plasma processing chamber;

forming the main etch gas into a plasma, while providing a first pressure;

maintaining a wafer temperature of less than 20° C;

ramping the pressure to a second pressure less than the first pressure as the plasma etches through a plurality of the plurality of silicon based bilayers; and

stopping the flow of the main etch gas after a first plurality of the plurality of bilayers is etched.

2. The method, as recited in claim 1, wherein the main etch gas comprises a fluorocarbon and $NF_3$.

3. The method, as recited in claim 2, wherein the maintaining the wafer temperature maintains a wafer temperature of less than 10° C.

4. The method, as recited in claim 3, wherein the first pressure is between 30 mtorr to 60 mtorr.

5. The method, as recited in claim 4, wherein the fluorocarbon is a hydrofluorocarbon.

6. The method, as recited in claim 5, wherein the forming the main etch gas into a plasma comprises providing an inductively coupled power to a upper power source placed on a first side of the wafer and providing a bias power to a bottom electrode on a second side of

the wafer opposite the first side of the wafer wherein the bias power has a frequency between 100 kHz and 1 MHz.

7. The method, as recited in claim 6, wherein each silicon based bilayer comprises a polysilicon layer and a silicon oxide layer.

8. The method, as recited in claim 7 where there are at least 16 bilayers and wherein the first plurality is at least 12 bilayers, and wherein the ramping provides at least six different pressures over which the 12 bilayers are etched.

9. The method, as recited in claim 8, wherein the etch features are vias with an aspect ratio of at least 20:1.

10. The method, as recited in claim 9, further comprising an over etch after stopping the flow of the main etch gas for etching remaining unetched bilayers, wherein the over etch comprises:

flowing an over etch gas which is more polymerizing than the main etch gas and comprising $NF_3$ into the plasma processing chamber;

forming the over etch gas into a plasma; and

stopping the flow of the over etch gas.

11. The method, as recited in claim 10, wherein the over etch further comprises increasing the wafer temperature from the main etch.

12. The method, as recited in claim 11, wherein the over etch further comprises lowering the pressure from the main etch;

13. The method, as recited in claim 1, wherein the maintaining the wafer temperature maintains a wafer temperature of less than 10° C.

14. The method, as recited in claim 1, wherein the first pressure is between 30 mtorr to 60 mtorr.

15. The method, as recited in claim 1, wherein the fluorocarbon is a hydrofluorocarbon.

16. The method, as recited in claim 1, wherein the forming the main etch gas into a plasma comprises providing an inductively coupled power to a upper power source placed on a first side of the wafer and providing a bias power to a bottom electrode on a second side of the wafer opposite the first side of the wafer wherein the bias power has a frequency between 100 kHz and 1 MHz.

17. The method, as recited in claim 1, wherein each silicon based bilayer comprises a polysilicon layer and a silicon oxide layer.

18. The method, as recited in claim 1 where there are at least 16 bilayers and wherein the first plurality is at least 12 bilayers, and wherein the ramping provides at least six different pressures over which the 12 bilayers are etched.

19. A method for etching features in a plurality of silicon based bilayers forming a stack on a wafer in a plasma processing chamber, comprising:

flowing an main etch gas comprising a fluorocarbon and $NF_3$ into the plasma processing chamber;

forming the main etch gas into a plasma, while providing a first pressure between 30 mtorr to 60 mtorr;

maintaining a wafer temperature of less than 10° C;

ramping the pressure to a second pressure less than the first pressure as the plasma etches through a plurality of the plurality of silicon based bilayers; and

stopping the flow of the main etch gas after a first plurality of the plurality of bilayers is etched.