CLAIMS

1. A method of etching a feature in a stack comprising dielectric material while fabricating a 3D NAND structure, the method comprising:

receiving a substrate on a substrate support in a reaction chamber, the substrate comprising the stack and a mask layer that is patterned on top of the stack, wherein the stack comprises either (a) alternating layers of silicon oxide and silicon nitride, or (b) alternating layers of silicon oxide and polysilicon; and

exposing the substrate to a plasma in the reaction chamber to thereby etch the feature in the stack on the substrate,

wherein the plasma is generated from a plasma generating gas comprising WF_6, Kr, one or more fluorocarbons and/or hydrofluorocarbons, and one or more oxidant, wherein a flow rate of the WF_6 is between about 0.1-10 sccm, wherein a flow rate of the Kr is between about 30-120 sccm,

wherein the plasma is a capacitively coupled plasma,

wherein the substrate is biased at a frequency between about 20 kHz and 1.5 MHz at an RF power level between about 500W – 20 kW per substrate,

wherein the WF_6 and the one or more fluorocarbons and/or hydrofluorocarbons form a tungsten-based polymer film on sidewalls of the feature during etching, and wherein the tungsten-based polymer film promotes a uniform etch rate between the (a) alternating layers of silicon oxide and silicon nitride, or between the (b) alternating layers of silicon oxide and polysilicon such that the sidewalls of the feature do not become notched during etching.

2. The method of claim 1, wherein during etching, the WF_6 dissociates into tungsten-containing fragments and fluorine-containing fragments, and wherein the tungsten-containing fragments remain relatively more concentrated near a top of the feature, as compared to the fluorine-containing fragments, and the fluorine-containing

fragments penetrate deeper into the feature, as compared to the tungsten-containing fragments.

3. The method of claim 2, wherein the tungsten-based polymer film has a non-uniform composition along the sidewalls of the feature such that the tungsten-based polymer film near the top of the feature has a greater proportion of tungsten, as compared to the tungsten-based polymer film near a bottom of the feature.

4. The method of claim 1, wherein the plasma is generated at an excitation frequency between about 20 MHz and 100 MHz and at an RF power of about 6.3 kW or less.

5. The method of claim 4, wherein the oxidant is O_2, and wherein a flow rate of the O_2 is between about 20-150 sccm.

6. The method of claim 5, wherein the plasma generating gas further comprises SF_6, and wherein a flow rate of the SF_6 is between about 1-20 sccm.

7. The method of claim 1, wherein the plasma generating gas further comprises NF_3, and wherein a flow rate of the NF_3 is about 30 sccm or less.

8. The method of claim 7, wherein the one or more fluorocarbons and/or hydrofluorocarbons comprise one or more of C_4F_8, C_3F_8, C_4F_6, and CH_2F_2, and wherein a total flow rate of the one or more fluorocarbons and/or hydrofluorocarbons is between about 30-240 sccm.

9. The method of claim 8, wherein the substrate support is maintained at a temperature between about 20-80°C while etching the substrate.

10. The method of claim 9, wherein a pressure in the reaction chamber is maintained between about 10-80 mTorr while etching the substrate.

11. The method of claim 10, wherein the feature is etched into the (a) alternating layers of silicon oxide and silicon nitride.

12. The method of claim 10, wherein the flow rate of the WF_6 is between about 0.02% and 10% of a total flow rate of the plasma generating gas.

13. The method of claim 12, wherein the flow rate of the WF_6 is between about 0.02% and 1% of a total flow rate of the plasma generating gas.

14. The method of claim 13, wherein the flow rate of the WF_6 is between about 0.02% and 0.5% of a total flow rate of the plasma generating gas.

15. The method of claim 1, wherein the substrate is biased at an RF frequency between about 300 kHz and 600 kHz.

16. The method of claim 15, wherein the substrate is biased at an RF frequency of about 400 kHz.

17. The method of any one of claims 1-16, wherein the tungsten-based polymer film forms at a first thickness on the layers of silicon oxide and at a second thickness on the layers of silicon nitride or polysilicon, the first and second thicknesses being different.

18. An apparatus for etching a feature in a stack comprising dielectric material while fabricating a 3D NAND structure on a substrate, the apparatus comprising:

a reaction chamber having a substrate support therein;

a capacitively coupled plasma generator;

an inlet for introducing material to the reaction chamber;

an outlet for removing material from the reaction chamber; and

a controller configured to cause:

receiving the substrate on the substrate support in the reaction chamber, the substrate comprising the stack and a mask layer that is patterned on top of the stack, wherein the stack comprises either (a) alternating layers of silicon oxide and silicon nitride, or (b) alternating layers of silicon oxide and polysilicon,

generating plasma from a plasma generating gas comprising WF_6, Kr, one or more fluorocarbons and/or hydrofluorocarbons, and one or more oxidant, wherein a flow rate of the WF_6 is between about 0.1-10 sccm, and wherein a flow rate of the Kr is between about 30-120 sccm,

biasing the substrate at a frequency between about 20 kHz and 1.5 MHz at an RF power level between about 500W – 20 kW, and

exposing the substrate to the plasma in the reaction chamber to thereby etch the feature in the stack on the substrate,

wherein the WF_6 and the one or more fluorocarbons and/or hydrofluorocarbons form a tungsten-based polymer film on sidewalls of the feature during etching, and wherein the tungsten-based polymer film promotes a uniform etch rate between the (a) alternating layers of silicon oxide and silicon nitride, or between the (b) alternating layers of silicon oxide and polysilicon such that the sidewalls of the feature do not become notched during etching.