CLAIMS

1. A method for etching features in an etch layer, comprising:

a) providing a conditioning for a patterned pseudo-hardmask of amorphous carbon or polysilicon disposed over the etch layer, wherein the conditioning comprises:

providing a fluorine free deposition gas comprising a hydrocarbon gas;

then forming a plasma from the fluorine free deposition gas;

providing a bias less than 500 volts; and

then forming a deposition on top of the patterned pseudo-hardmask; ~~and~~

b) then etching the etch layer through the patterned pseudo-hardmask; and

then removing the pseudo-hardmask layer after etching the etch layer.

2. The method, as recited in claim 1, further comprising repeating steps a and b at least twice and wherein the deposition has a top thickness, which is a thickness of the deposition on top of the patterned pseudo-hardmask and a sidewall thickness, which is the maximum thickness on sidewalls of the patterned pseudo-hardmask, wherein the top thickness is at least twice the sidewall thickness.

3. The method, as recited in claim 2, wherein the pseudo-hardmask is polysilicon and wherein the fluorine free deposition gas further comprises oxygen.

4. The method, as recited in claim 2, wherein the etching the etch layer forms a

plurality of lines in the etch layer, wherein the lines have widths of no more than 20 nm and thicknesses of at least 100 nm.

5. The method, as recited in claim 2, further comprising: forming an amorphous carbon layer over the etch layer; forming an antireflective layer over the pseudo-hardmask layer; forming a patterned photoresist layer over the antireflective layer; and transferring a pattern of the patterned photoresist layer to the pseudo-hardmask layer.

~~3~~6. The method, as recited in claim 2, wherein the pseudo-hardmask is amorphous carbon and wherein the fluorine free deposition gas further comprises nitrogen.

47. The method, as recited in claim ~~3~~ 6, wherein the top thickness is at least five times the maximum thickness on the sidewalls.

~~5~~8. The method, as recited in claim ~~4~~ 7, wherein the hydrocarbon gas comprises C_2H_4 or CH_4.

~~6~~9. The method, as recited in claim ~~5~~ 8, wherein the etch layer is a silicon oxide based material.

~~7~~10. The method, as recited in claim ~~6~~ 9, wherein the etch layer further comprises nitrogen and hydrogen.

~~8~~11. The method, as recited in claim ~~5~~ 8, further comprising:

forming an amorphous carbon layer over the etch layer;

forming an antireflective layer over the pseudo-hardmask layer;

forming a patterned photoresist layer over the antireflective layer; and

transferring a pattern of the patterned photoresist layer to the pseudo-hardmask layer.

~~9~~12. The method, as recited in claim ~~5~~ 8, wherein the fluorine free deposition gas further comprises silicon containing component.

~~10~~13. The method, as recited in claim ~~5~~ 8, wherein the forming a plasma from the fluorine free deposition gas comprises providing an RF signal of at least 60 MHz and a pressure of less than 5 mTorr.

~~11~~14. The method, as recited in claim ~~5~~ 8, wherein the forming a plasma from the fluorine free deposition gas comprises providing an RF signal of less than 20 MHz and a pressure of greater than 100 mTorr.

~~12~~15. The method, as recited in claim ~~5~~ 8 wherein the bias is less than 300 volts.

~~13. The method, as recited in claim 2, wherein the pseudo-hardmask is polysilicon and wherein the fluorine free deposition gas further comprises oxygen.~~

~~14. The method, as recited in claim 2, wherein the etching the etch layer forms a plurality of lines in the etch layer, wherein the lines have widths of no more than 20 nm and thicknesses of at least 100 nm.~~

~~15. The method, as recited in claim 2, further comprising:~~

~~forming an amorphous carbon layer over the etch layer;~~

~~forming an antireflective layer over the pseudo-hardmask layer;~~

~~forming a patterned photoresist layer over the antireflective layer; and~~

~~transferring a pattern of the patterned photoresist layer to the pseudo-hardmask layer.~~

~~16. The method as recited in claim 15, further comprising removing the pseudo-hardmask layer after etching the etch layer.~~

~~17~~16. A method for etching features in an etch layer, comprising:

a) forming an amorphous carbon layer over the etch layer;

b) then forming an antireflective layer over the amorphous carbon layer;

c) then forming a patterned photoresist layer over the antireflective layer;

d) then transferring a pattern of the patterned photoresist layer to the amorphous carbon layer to form a patterned amorphous carbon mask;

e) then providing a conditioning for the patterned amorphous carbon mask, wherein the conditioning comprises:

providing a fluorine free deposition gas comprising nitrogen and a hydrocarbon gas comprising C_2H_4 or CH_4;

forming a plasma from the fluorine free deposition gas; and

forming a deposition on top of the patterned amorphous carbon mask wherein the deposition has a top thickness, which is a thickness of the deposition on top of the patterned amorphous carbon mask and a sidewall thickness, which is the maximum thickness on sidewalls of the patterned amorphous carbon mask, wherein the top thickness is at least twice the sidewall thickness; and

f) then etching the etch layer through the patterned amorphous carbon mask, wherein steps e and f are cyclically repeated a plurality of times;

g) then removing the patterned amorphous carbon mask.

~~18~~17. The method, as recited in claim ~~17~~ 16, wherein the providing the conditioning further comprises providing a bias less than 500 volts.

~~19. An apparatus for etching features in an etch layer, said apparatus comprising:~~

~~a plasma processing chamber, comprising:~~

~~a chamber wall forming a plasma processing chamber enclosure;~~

~~a chuck for supporting and chucking a substrate within the plasma processing chamber enclosure;~~

~~a pressure regulator for regulating the pressure in the plasma processing chamber enclosure;~~

~~at least one electrode or coil for providing power to the plasma processing chamber enclosure for sustaining a plasma;~~

~~a gas inlet for providing gas into the plasma processing chamber enclosure; and~~

~~a gas outlet for exhausting gas from the plasma processing chamber enclosure;~~

~~a gas source in fluid connection with the gas inlet, comprising:~~

~~a fluorine free deposition gas source; and~~

~~an etch gas source;~~

~~a controller controllably connected to the gas source, the chuck, and the at least one electrode or coil, comprising:~~

~~at least one processor; and~~

~~non-transient computer readable media, comprising:~~

~~computer readable code for providing a conditioning for a patterned pseudo-hardmask of amorphous carbon or polysilicon disposed over the etch layer, wherein the conditioning comprises:~~

~~computer readable code providing a fluorine free deposition gas comprising a hydrocarbon gas;~~

~~computer readable code for forming a plasma from the fluorine free deposition gas;~~

~~computer readable code for providing a bias less than 500 volts; and~~

~~computer readable code for forming a deposition on top of the patterned pseudo-hardmask wherein the deposition has a top thickness, which is a thickness of the deposition on top of the patterned pseudo-hardmask and a sidewall thickness, which is the maximum thickness on sidewalls of the patterned pseudo-hardmask, wherein the top thickness is at least twice the sidewall thickness;~~

~~computer readable code for etching the etch layer through the patterned pseudo-hardmask; and~~

~~computer readable code for cyclically repeating the conditioning and etching at least twice.~~